December/January, 1980
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Scientists and Human Rights

Cancer: Deadly, Inflationary, Preventable

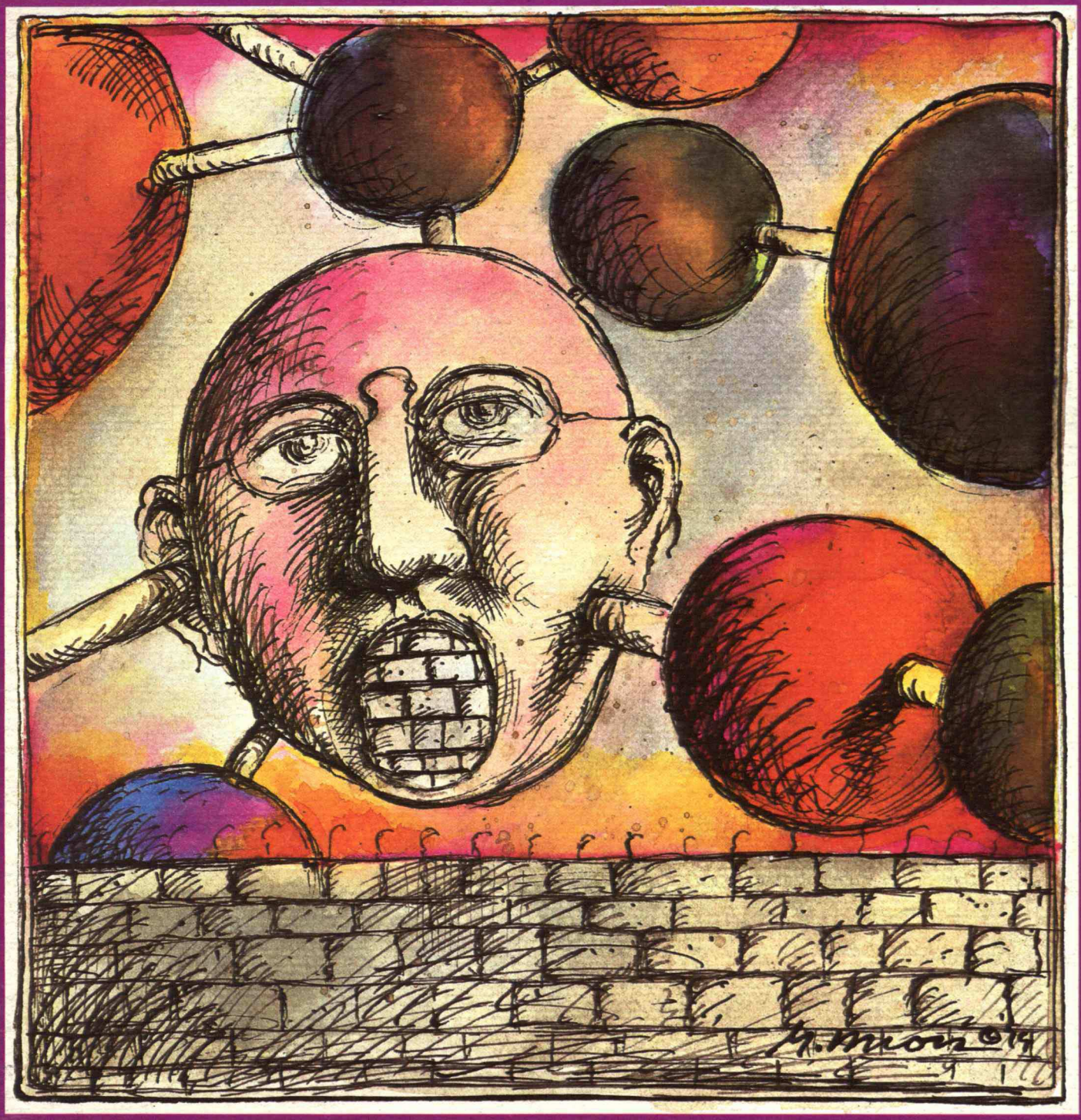
Artists on Technology

Electric Heating at Low Cost

"Information Workers" for the New Age

Technology Review

Edited at the Massachusetts Institute of Technology



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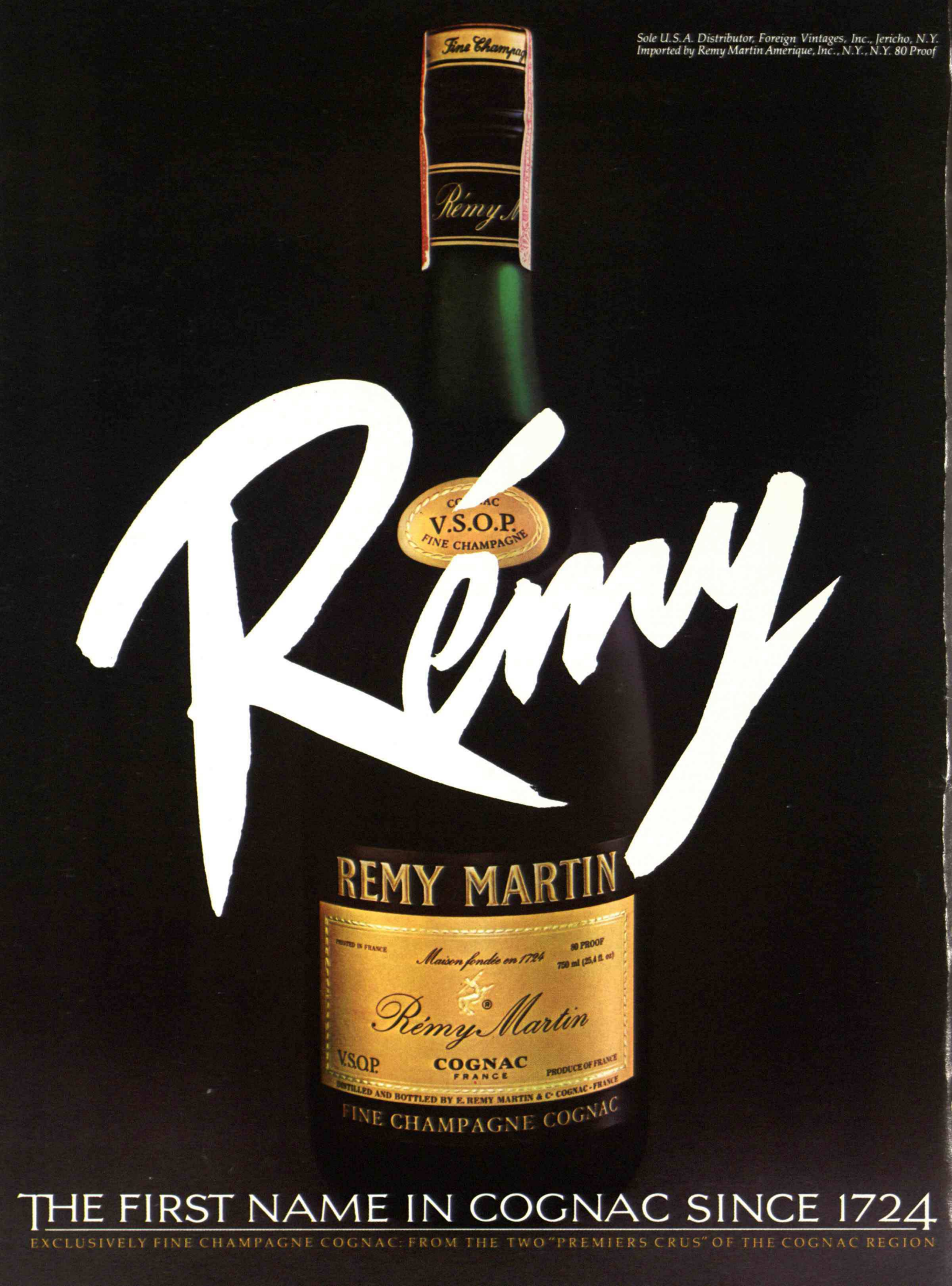
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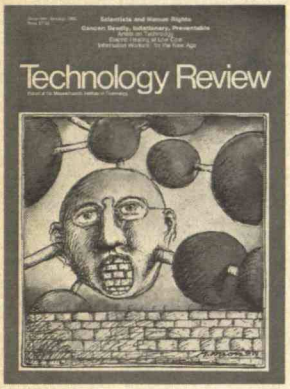
December/January 1980

Technology Review



Science and Human Rights
Page 20

Cover by
Geoffrey Moss

FEATURES

TREND OF AFFAIRS

COLUMNS

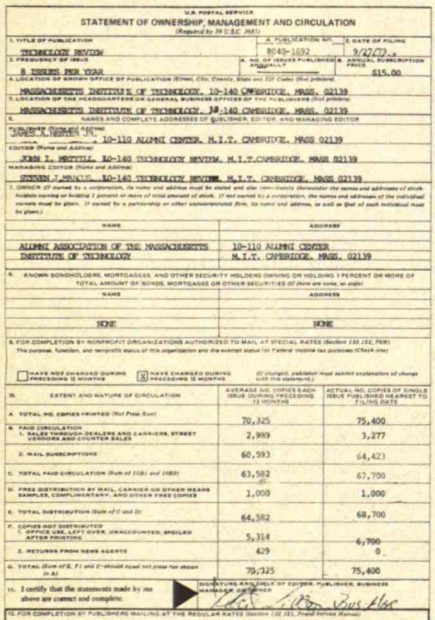
DEPARTMENTS

Can Science Be Poetry?

Behind the name of every author and the initials of every writer in a good magazine stands a team of anonymous workers: people who check facts, people who restore the standards of language and its use in the frequent cases where authors and editors have abandoned them, people who form tiny characters into words and then into pages, and people who seek out the mischief that inevitably is associated with all these transformations.

Susanne Fairclough undertook one of these anonymous assignments at *Technology Review* as a first job after graduating from Middlebury College in 1974. She brought with her the appropriate qualities of diligence and patience — and an uncommon supply of intelligence and common sense. As the years passed, though her inclinations may have been more toward poetry than science, Susanne's work became less and less anonymous — a trend which culminated in the November issue when we published her interview with Philip Morrison.

Now her passion for more poetic forms of expression has drawn Ms. Fairclough into her own work, and she has left *Technology Review*'s Board of Editors. But we rejoice — and readers should, too — in her assurance that she will continue occasional assignments as a contributing editor. — *J.M.*



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1. TITLE OF PUBLICATION: TECHNOLOGY REVIEW
A. PUBLICATION NO.: 8040-1692
2. DATE OF FILING: 9/27/79
3. FREQUENCY OF ISSUE: 8 ISSUES PER YEAR
A. NO. OF ISSUES PUBLISHED ANNUALLY:
B. ANNUAL SUBSCRIPTION PRICE: $15.00
4. LOCATION OF KNOWN OFFICE OF PUBLICATION (Street, City, County, State and ZIP Code) (Not printers)
MASSACHUSETTS INSTITUTE OF TECHNOLOGY, 10-140 CAMBRIDGE, MASS. 02139
5. LOCATION OF THE HEADQUARTERS OR GENERAL BUSINESS OFFICES OF THE PUBLISHERS (Not printers)
MASSACHUSETTS INSTITUTE OF TECHNOLOGY, 10-140 CAMBRIDGE, MASS. 02139
6. NAMES AND COMPLETE ADDRESSES OF PUBLISHER, EDITOR, AND MANAGING EDITOR
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(February)

Aircraft Ventilation Systems

Two different types of ventilation systems are used in Boeing 707 aircraft, and I conclude that the airplane tested by Mr. Walker (*"Flying and Fear of Smoking," Trend of Affairs, Oct., pp. 70-71*) was air conditioned by a vapor cycle (freon) cooled air recirculation system. This would provide the nearly uniform mixture of air he describes.

A very different result would have obtained had Mr. Walker's plane been equipped with an air cycle system, used almost exclusively in the latest classes of passenger aircraft. With such a system it is possible to distribute fresh, compressed, and cooled or heated air uniformly along the length of the passenger cabin. For example, the Lockheed 1011, with which I am familiar, supplies air in large overhead ducts to the cabin, where it is introduced through narrow slot diffusers which mix fresh air with cabin air by entrainment. The air then circulates down the walls and back up to the ceiling. A part of this circulating flow (equal to the fresh air inflow) is discharged through floor vents and ultimately out through the cabin pressure control valve. This system provides virtually no longitudinal flow, resulting in effective isolation of smoking and nonsmoking zones.

E. D. Berhold
Granada Hills, Calif.

A disadvantage of building quality machinery – like the 707 – is that it is around for a long time; at present 262 707s are registered with the F.A.A. for service, while only 93 1011s are registered. When the oldest of those 707s are phased out, nonsmokers may find themselves breathing a little easier when aloft. — Ed.

Analysis vs. Subjectivity

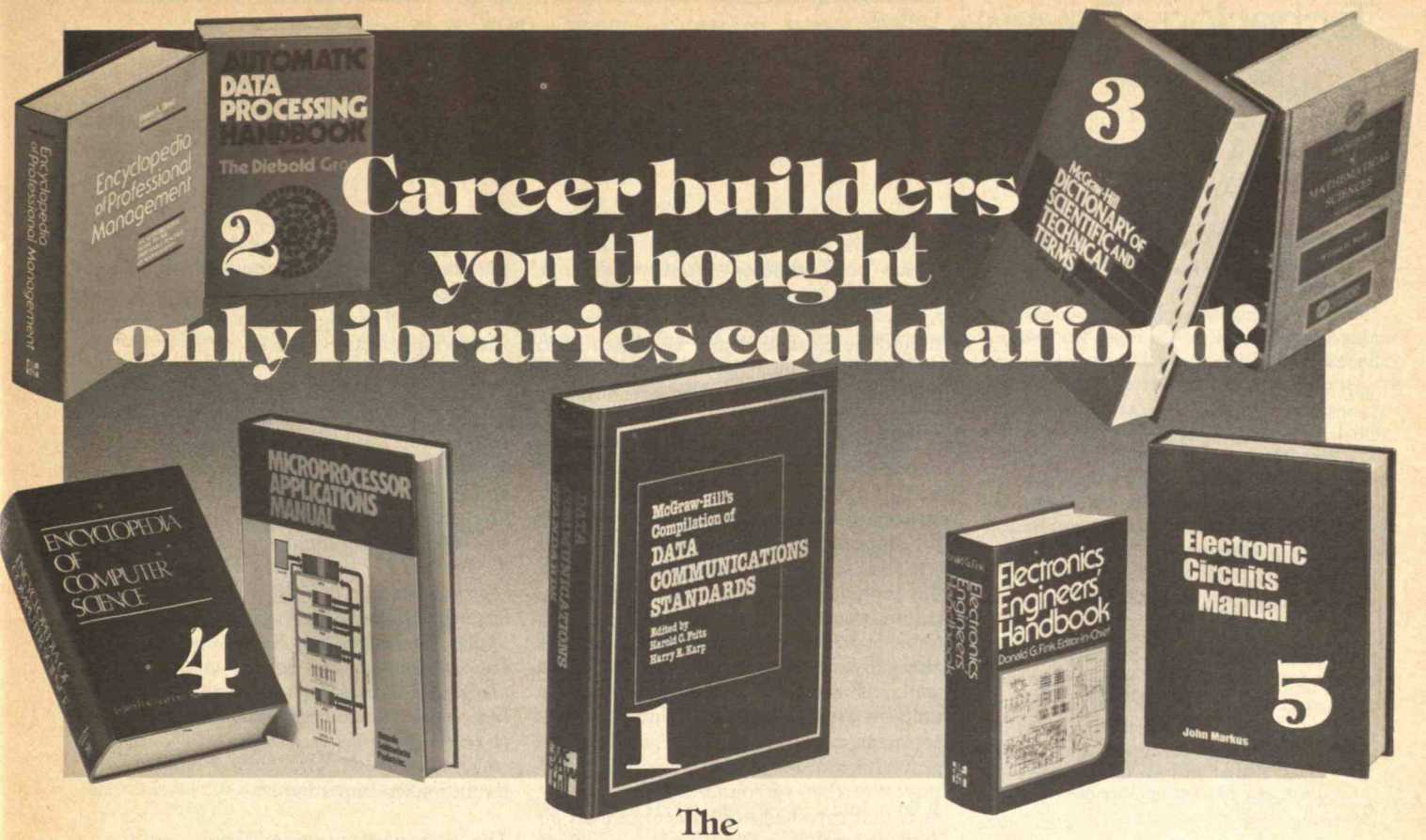
In "Subjectivity and Science" (*Feb., pp. 48-56*), Vince Taylor joins a growing number of dissidents who have been advancing the notion that the scientific method is inadequate and inappropriate for use in public policy deliberations. He holds that quantitative, scientific approaches to public policy analysis are too narrow in scope and prohibit the analyst from projecting intuitive knowledge of the world into a model formulation.

This criticism of the scientific approach to decision making occurs at a time when operations research methods are just beginning to be widely accepted by government. The military has used such methods for years, as has industry, and cost-benefit analysis has been applied to government-sponsored public works projects since the Flood Control Act of 1936. However, application of advanced operations research to high-level government policy making has been a recent phenomenon. It is also interesting — though not surprising — to me, as a nuclear engineer, that many who challenge scientific analysis also challenge nuclear power. Most risk-benefit studies have concluded in favor of nuclear power, and it is to be expected that critics would challenge the methods behind these results; some have gone the one step further to question the integrity of the analysts.

The critics argue that there are so many "externalities" and "intangibles" in policy matters that they cannot be handled by a scientific approach. I disagree with this conclusion because I believe that technological advances — nuclear weaponry, hazardous chemical poisons, germ-biological warfare, electronic computers, etc. — have unalterably changed the nature of national decision making. Decision makers are increasingly faced with extremely complex issues with far-reaching consequences for the present and future generations — consequences potentially disastrous on a scale previously unimaginable. Shall we encourage the widespread use of coal at the risk of greatly increasing global carbon dioxide levels? How should cancer risks be weighed against the benefits of small amounts of materials which are known to be carcinogenic in massive doses? (For example, a saccharin ban might actually increase mortality risk by adding to the heart attack rate among certain groups of people.) Should the U.S. deploy the B-1 bomber or MX missile system? These decisions are examples of choices between technological alternatives, each with its own set of risk-benefits. Such decisions as these do not lend themselves to simple intuitive resolution. They are not easily made without careful, objective analysis of their possible ramifications.

Traditionally, major policy issues have been debated in the political process, in which too often advocates present exaggerated positions which result in increased polarization rather than even-handed, rational decision making.

To balance such emotional appeals fostered in the arenas of the adversary process, we increasingly need independent, rational analysis done apart from political turmoil. In Washington, such independent analysis is materializing today in organizations such as the General Accounting



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Richard F. Wright, Littell-Murray-Barnhill, 7 Rockwood Rd., Natick, Mass., 01760, (617) 653-1568.

Technology Review (ISSN 0040-1692), Reg. U.S. Patent Office, is published eight times each year (in June/July, August/ September, October, November, December/January, February, March/April, and May) at the Massachusetts Institute of Technology; two special editions are provided for graduate (pp. A1-A32) and undergraduate (pp. A1-A32 and B1-B16) alumni of M.I.T. Entire contents copyright 1979 by the Alumni Association of the Massachusetts Institute of Technology. *Technology Review* is printed by The Lane Press, Inc., Burlington, Vt. Second class postage paid at Boston, Mass., and at additional mailing offices. Postmaster, send Form #3579 to Technology Review, M.I.T. Room 10-140, Cambridge, Mass. 02139.
Inquiries regarding editorial contents, subscriptions, and advertising should be addressed to: *Technology Review,* Room 10-140, M.I.T., Cambridge, Mass., 02139. Telephone area code (617) 253-8250. Unsolicited manuscripts are welcome, but no responsibility for safekeeping can be assumed.
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Office, the Library of Congress, and the Office of Technology Assessment. But they represent only a beginning; their roles — and the processes they embrace — should be expanded and enhanced, and policy makers must pay them more serious attention, relying on an ever-broader base of information.

Analysis structures issues as problems to be dealt with through the application of scientific principles. No matter how much information exists, no matter how large the degree of uncertainty, decisions can be analyzed in a quantitative fashion through the explicit assignment of likelihood distributions on key parameters. Thus it is possible to indicate the consequences of alternatives under a wide range of possible states. Though all decision making requires a certain amount of subjective assessment, expert or otherwise, analysis is a powerful tool for cutting away the verbal travesties that surround issues, exposing facts that can shed a great deal of light on decision making. This is not to suggest that analysis replace politics or that analysts replace politicians and policy makers. This is simply to suggest that analysis be granted a more important role in the political process.

It is my belief that clarity, understanding, and the desire to come to the truth can only be enhanced by a rational scientific approach toward policy analysis. Methods that resort exclusively to emotional appeal or rely solely on sheer intuition do not result in firm, reasoned conclusions. For these reasons, I urge the further adoption of rational analytic approaches to social decision making on a national level.

Carolyn D. Heising-Goodman
Cambridge, Mass.

The writer is a member of the Department of Nuclear Engineering at M.I.T.; she is, in fact, the anonymous student (then at Stanford University) to whom Dr. Taylor addressed his article, "Subjectivity and Science: A Correspondence about Belief." Dr. Heising-Goodman first wrote Dr. Taylor in 1977 to criticize his analysis of reprocessing and breeder reactor economics; his response to her was an essay from which the Technology Review *article was later developed. The editors assured Dr. Heising-Goodman of anonymity at the time of publication; she has since decided to respond to Dr. Taylor.*

Evolutionary Imperative

The rhetorical question "How could a being who was a hunter-gatherer a few million years ago suddenly find itself capable of going to the moon?" which Robert C. Cowen (*Aug./Sept., p. 10*) attributes to Bernard Cambell deserves at least one answer. Humans found themselves on another planet because that is the primary purpose of our existence. Humanity/technology is the result of an evolutionary imperative of nature to allow life to be seeded beyond the confines of a single planet in a single star system. Humanity/technology is nature's recognition of the perilous problem of being confined to a single location in a dynamic universe.

William J. Sauber
Midland, Mich.

The Deadly Microwave Myth

The "worrisome 'fricassee threat' of errant microwaves," alluded to as a hazard of space solar energy ("*Off the Wall and Into Orbit," Trend of Affairs, Aug./Sept., pp. 76-77*), is worrisome as an example of how plausible rumors infiltrate and distort public debate.

The facts are that microwave beams proposed for the transmission of electric power from space to earth would be about one quarter the intensity of sunlight. This power density could not "fricassee" anything, even if the beam fell in the wrong place. However, the beam could not fall in the wrong place because the transmission system would require the cooperation of the receiving antenna to form any beam at

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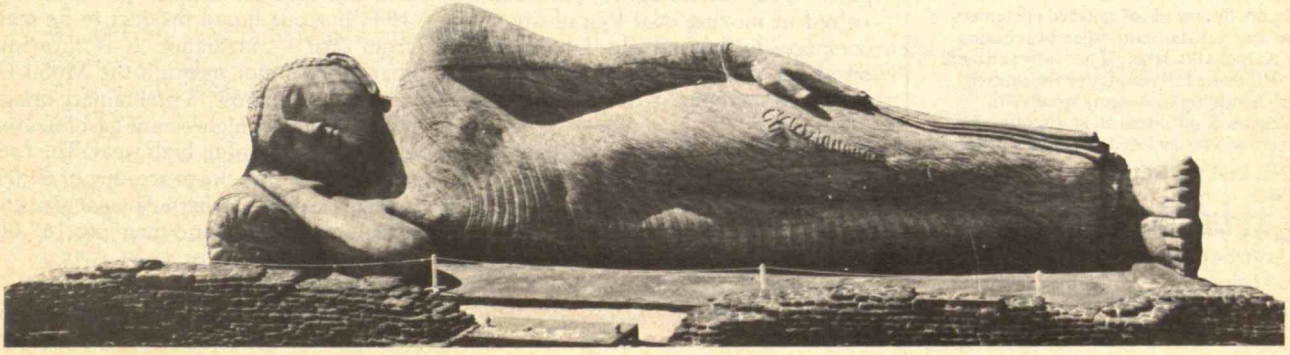


all. Microwave power, furthermore, differs from ionizing radiation. Solar power satellites can be designed to meet the strictest public exposure standards in the world, far stricter than those in the U.S. today.
E. Eric Drexler
Cambridge, Mass.

Mr. Drexler errs when he compares microwave power to sunlight; it is like a comparison of apples and oranges. We do not know the long-term effects of exposure to microwave radiation; medical opinion is far from unanimous in this area, probably because etiological data are so few and so controversial. – Ed.

Nuclear Rationality Flawed

"Nuclear Power: Can We Live with It?" (*June/July, pp. 32-47*) was flawed significantly by the inclusion of Mr. Kleitman's gratuitous comment with respect to people at utilities on page 42. This is exactly the sort of aside which damns serious consideration of major issues. I believe it is especially significant because the article is not represented as a verbatim report but as an edited transcript of the discussion.

It seems to me that the editor might well have disregarded this remark as well as the following parenthetical comment if his intention was to convey to the reader that this highly important issue could be discussed in a rational way by informed people who have differing perspectives.
A. F. Corry
Boston, Mass.

Mr. Corry is senior vice president of Boston Edison Co. – Ed.

Coal and the Railroads: Can Do?

The continued use of a surrealist arithmetic by opponents of railroad transport of coal (*see "Coal: The Ace-in-the-Hole That Isn't There," Trend of Affairs, March/April, p.68*) is puzzling. To transport 60 million tons of coal a year would require one 100-car train each 87.6 minutes, not "two or three an hour" as you cite. Also puzzling is the statement that the railroads may need $7 to $10 billion for "new technology" as well as "creative management to use it." The plain implication is that existing technology and present management are inadequate for the task. But 10,000-ton unit trains are now hauling millions of tons of coal each year from Montana and Wyoming to the Midwest and soon will be doing the same to Texas and Louisiana; the brains of railroad management seem fully capable of dealing with the rather simple technology involved — and are much better at arithmetic than some of their critics.

By 1990 Western coal may be moving eastward and southward at a rate considerably greater than 60 million tons a year, but all of the coal will pass through no single community, and certainly no single Colorado community, since it will be coming from and going to different places by different routes.

The dollar costs, environmental impacts, and technological problems involved in moving coal by rail are trivial compared to those involved in developing oil shale, synthetic liquid fuels, or geopressured methane.
Earl Cook
College Station, Texas

The writer is dean of geosciences at Texas A & M University. William F. Lipman, one of the participants in the panel whose conclusions were reported by Technology Review, *responds:*

As the *Review* reported, the panel found that relying on coal, as with any national energy "fix," entails costs, some of which are likely to be formidable and have been underexamined; that some of these costs are linked to the predominant role that rail transport must play in a coal-fired economy; and that the U.S. railroad industry may have some difficulty fulfilling this role.

Whatever the particular figures, the environmental impacts that arise when coal moves by rail are not trivial in comparison with other sources. At least to people living in Colorado, the movement of 20 to 50 unit trains per day (including empties as returns) through a populated corridor creates an environmental impact, and I believe that view is shared throughout the Rocky Mountain and high-plains states. And bear in mind that the *Review*'s figures did not include the megatons of sludge and ash that will have to be hauled away.

The ability of the railroad industry to move the volume of coal set forth in the National Energy Plan and in many similar scenarios for the 1980-2000 period remains in question. Whatever the arithmetic, I wouldn't advise setting one's watch by that 87.6-minute headway figure.

A study performed for a group of carriers by Richard J. Barber and Associates, one of the nation's most prestigious consulting firms in the area of transport finance, found that the railroad industry would have to spend $40 billion by 1985, of which coal-related investments would conservatively total 10 per cent — which is substantially less than the $7 to $10 billion cited by the *Review*, and twice the level of recent outlays. But other sources have made estimates ranging from $5 to $11.5 billion, depending on the intervals chosen and what is included in the estimate.

Coal to Gasoline

In his "Synthetic Fuels at the Crossroads" (*August/September, pp. 24-35*), Charles A. Stokes lists for commercialization after 1985 but one liquid product to be made from coal — methanol. It is surprising that he does not mention the Mobil Oil Corp. process, now in preliminary design, which produces high-octane gasoline from coal via methanol in high yield. The present design shows the processing of 63,000 tons per day of southern Appalachian coal first into methanol and then into 167,000 barrels of gasoline.
Ernest W. Volkmann
Latrobe, Pa.

An Evolutionary View of Technology Forecasting

Kenneth E. Boulding is director of the Institute of Behavioral Science and professor emeritus of economics at the University of Colorado at Boulder. He is a regular contributor to Technology Review.

I have worried a good deal lately about how our images of the future can be improved. All decisions, from the most momentous to the most trivial, involve choice among alternative images of the future. If our images are unrealistic, our decisions will inevitably lead to disappointment. To improve human decision-making we must first gain more accurate images of the future from which to choose and then develop better ways to evaluate these respective images.

Images of the future are formed by the projection of patterns that we perceive in the records of the past. Improving our view of the future then involves improving the records of the past. This largely gave rise to our ability to predict eclipses and movements of the solar system. Next, we must perceive patterns in these records, which we think will be repeated.

There seem to be three main types of patterns. The first, and clearly the most successful in prediction, are mechanical patterns, like those of celestial mechanics which consist essentially of stable patterns in space-time. They can often be described by difference or differential equations of a reasonable degree. We experience something like this almost subconsciously in daily life. Every time we turn left against a stream of traffic or hit a tennis ball, we perceive something coming towards us, estimate its velocity, and try to make some prediction of its future velocity. This enables us to predict where it is going to be in the next few seconds.

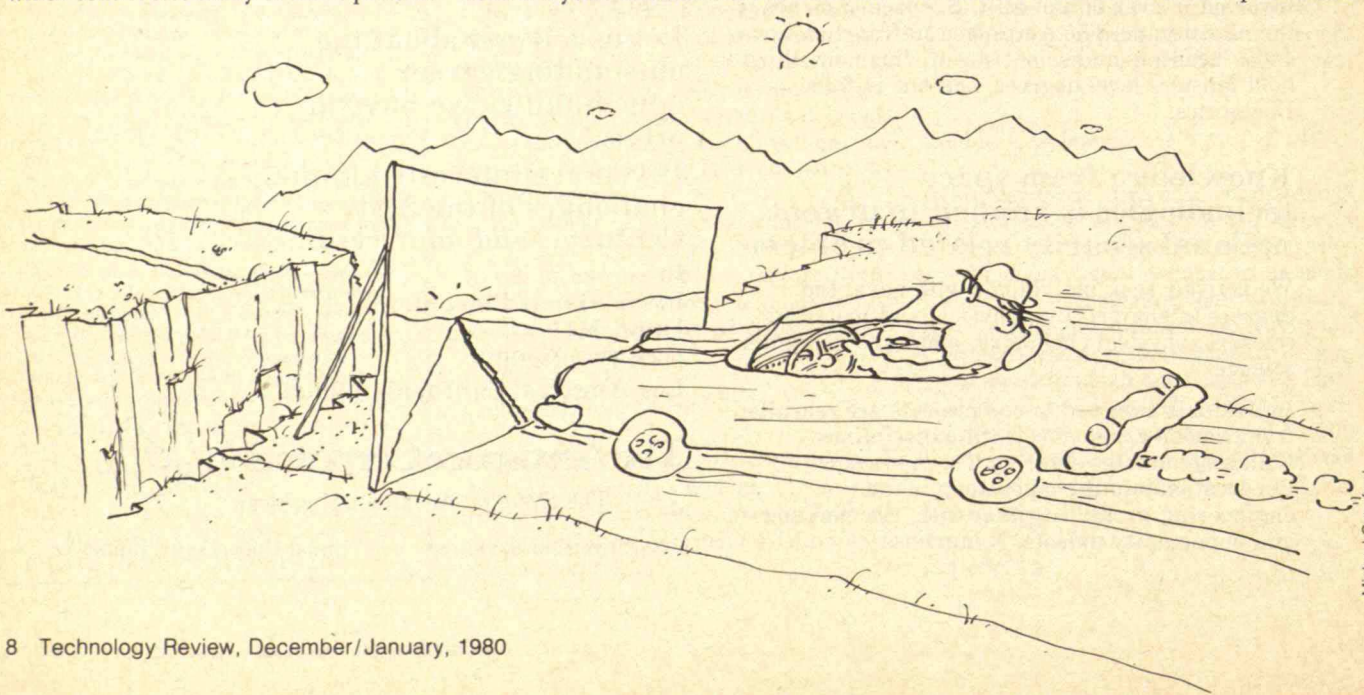
When we have accurate records of the past which exhibit patterns of stable parameters, we can be fairly confident of mechanical predictions. However, the range of systems of this kind is limited. There are many systems which do not exhibit such patterns. The throw of the dice is a good example. Carefully recorded time series of the numbers thrown will never enable us to predict the next throw, although it may enable us to state its probability. The search for mechanical patterns in random series can only lead to superstition, the perception of order where there is none. This is particularly dangerous because any finite random series will have some kind of order, though there is no guarantee whatsoever that the order will persist.

As we move into biological and social systems, mechanical patterns and predictions become less and less applicable. Nobody knows (or I think would want to know) the date of his or her own death. We can make some estimate of the probability of our dying within a given period in the future, but even this may not be very accurate for a single individual. I can predict with some confidence that I will be dead in x years and that San Francisco will be destroyed by an earthquake in y years; if the present international system continues, the United States will be destroyed by a nuclear war in z years. I do not know the values of x, y, or z but can put some figure on them that makes these statements highly probable; let's say 25 years for x, 100 years for y, and 100 years for z.

"Episodic Analysis"

Propositions of this kind are apt to be derived from what might be called "episodic analysis," the perception not of a generalized and universal pattern in the past but of a pattern of episodes like randomly placed roses on the wallpaper. We recognize when we are at the beginning of one of these, and the record of the past tells us something about what to expect. Biological lifespans are an excellent example. We have every confidence that a kitten, if it does not die first, will grow up into a cat, never into a hippopotamus. The lifespan of human beings is regular enough so that we have a great deal of confidence that babies born today (if they do not die first, and if they go to college at all) will be going to college in about 1997 or 1998. And if they marry, they will probably be married by 2010 and will almost certainly be dead by 2080. Depressions, wars, inflations have a certain episodic character, although the episodes are much less regular than with biological lifespans. Episodes are most likely to be regular when they follow a plan such as is contained in a fertilized egg.

The third pattern that we perceive in the records of the past is the general pattern of evolution. This is even less predictable



Michael Crawford

than patterns of episodes, though it may contain these. I define evolution as ecological interaction under conditions of constantly changing parameters. Ecological interaction is selection; change in parameters is mutation. Selection may be a moderately mechanical process, or at least episodic. If we postulate an equilibrium of an ecosystem, there may be a fairly regular path towards this equilibrium, although the interactions involved are complex. A mechanical system of a thousand parameters is pretty hard to specify. Celestial mechanics is successful not only because the solar system is approximately an equilibrium system in space-time, the evolution of which has virtually ceased, but also because it has relatively few parameters. The number of parameters in biological ecosystems is very large; in social systems the number is even larger. We are constantly being surprised by parameters that we have failed to identify, like the impact of DDT on birds or of internal combustion engines on the quality of our air.

Evolution and the Empty Niches

When it comes to mutation, quite strong random elements are involved in parametric change. We can see evolution proceeding through the filling of empty niches in ecosystems by mutations of different kinds, whether in genetic know-how, in opening up of migrations, in soil erosion and formation, or in climatic change. The probability that an empty niche will be filled, however, is never 1.0. If its filling is delayed, it will eventually close, and the whole history of the universe will be different from what it would have been if it had been filled. There is a profound and irreducible indeterminancy, therefore, in the evolutionary process, and mechanical systems can never describe it.

Even in this case, however, prediction is not impossible. We can look for the empty niches in existing systems and guess the probability that they might be filled. Each niche as it is filled will, of course, change all the other niches in the system, whether filled or unfilled — some will expand and some will contract. We have some chance, perhaps, of identifying these processes.

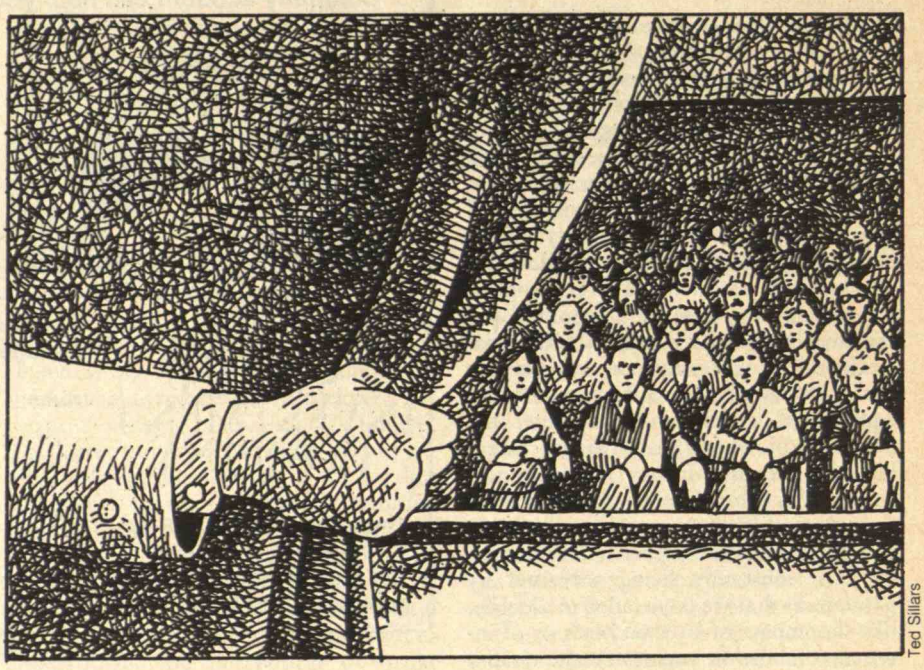
The history of human technology and the extraordinary difficulty of predicting it is a good illustration of these principles. Successful technological change represents a mutation, a change in the parameters of the system by invention, discovery, or migration. In 1800 there was a biological empty niche for rabbits in Australia, and there was a societal empty niche for European people and artifacts there. In 1858 there was a niche for a substitute for whale oil, which was closing on the supply side. Niches can close either because of a lack of births or too many deaths of the species which occupy them. The discovery of oil produced kerosene, a fine substitute for whale oil. This produced gasoline as an unneeded by-product, which created an empty niche for the internal combustion engine, which was filled in the 1880s by invention. The automobile created empty niches for highways, cement, gas stations, and supermarkets.

The automobile niche may be closing as oil deposits are exhausted and fuel becomes more expensive. This may open a niche for the electric automobile; for cheap electricity storage, or alternative energy storage; for photoelectric cells, and so on.

Whether we can improve technological prediction by this method, I am not sure. The record of the past has been dismal. Nobody predicted the automobile and its effects. Nobody predicted the computer. In demography, nobody predicted the great bulge in fertility of the 1950s or the trough of the 1960s and 1970s. It is hard to believe that this record could not be improved, though I am not sanguine about its being improved very much. □

Particle Physics: Poised for a Breakthrough

Robert C. Cowen, Science Editor of the Christian Science Monitor, *is former president of the National Association of Science Writers and is a regular contributor to the* Review. *He holds S.B. and S.M. degrees in meteorology from M.I.T.*



Ted Sillars

Nineteen seventy nine was a banner year for particle physics. Strong, if not definitive, evidence for a new kind of basic force and associated subatomic particle emerged from some of the first experiments with a new German accelerator facility. The award of a Nobel prize recognized that a unification of certain fundamental forces may be underway — an achievement to match the unification Maxwell demonstrated between electricity and magnetism in the last century. And the European Center for Nuclear Research at Geneva (CERN) celebrated its 25th anniversary proving, among other things, that despite the divisiveness of international politics, scientists from many lands can work together.

In fact, high-energy physicists would be going about with the broadest of grins if the edge weren't taken off their joy by the pinch of inadequate budgets and the ennui of standing in line for the limited number of places in the experimental halls of the great accelerators. Yet smile they must, for they sense that particle physics is poised for a breakthrough in knowledge. It could be as profound in its way as were the insights gained through the development of relativity, quantum theory, or Maxwell's electromagnetism.

Physicists now think in terms of four basic forces or, as they often call them, "interactions" — gravity, electromagnetism, and the so-called strong and weak forces. The strong force holds atomic nuclei together. The weak force, a billion times weaker than the strong coupling, mediates many radioactive decay processes. These two forces are the focus of much of the excitement in particle physics.

For example, the more physicists probe the nature of particles like protons or neutrons which "feel" the strong interaction, the more it looks like this interaction is only the manisfestation of a new kind of fundamental force. This force has the novel feature of being weak when the particles it binds are close together and of growing stronger as these particles try to separate. A continuing flow of evidence points to the existence of this force and its associated particles. None of the new findings prove these exist. Yet, taken together, they strongly imply the validity of a theory of subatomic structure based on this force which so far has served only as a working guide.

Since this theory describes much of the physical foundation of the material world, its verification would rank with the well-tested theory of electromagnetic force. How soon such unambiguous confirmation may come is uncertain, but it will likely happen slowly, step by step. However, as new accelerator facilities allow physicists to probe matter at the energies necessary to furnish this proof, at least partial confirmation seems assured.

The Matter (and Antimatter) of Quarks

In seeking this proof, physicists are working with a particle concept called a quark. Protons, neutrons, and similar particles seem to have an inner structure. They seem to be made up of still more basic particles, which are the quarks. The detectors that surround the target areas of particle accelerators show no direct traces of any such particle. But as the accelerators smash protons into protons or electrons into positrons, they sometimes produce the kinds of debris expected if the quark concept is right.

Quarks are thought to come in both matter and antimatter form. Antimatter is like ordinary matter except that certain properties are reversed. Thus a positron is the positively charged antimatter form of the electron. Matter and antimatter annihilate one another when they meet, transforming their mass into radiant energy. Conversely, pairs of matter-antimatter particles can form out of pure energy. These processes of creation and transformation produce the distinctive patterns of debris which physicists are looking for in accelerator experiments.

Physicists now speak of six "flavors" of quarks, each paired with its antiquark. Only five of the "flavors" have been verified experimentally but conceivably there could be more. The six are "up," "down," "strange," "charmed," "bottom" or "beauty," and "top" or "truth" (not yet experimentally confirmed). Perhaps because these things are so abstract, physicists give full reign to their whimsy in naming them. The term quark is one of James Joyce's carefully coined "nonsense" words in *Finnegan's Wake*. In their search for unambiguous manifestations of quark properties, physicists talk about seeking naked beauty or revealed truth. This inspired *Science News* to come up with the headline, "Bare Bottom; Naked Charm: Booms-a-daisy Physics."

Behind this chorus line of quarks lurks the mysterious new force. It enables quarks to act as free particles when close together but binds them ever more strongly when they tend to move apart.

Many theorists think this would prevent isolated quarks from ever appearing directly in accelerator experiments. Physicists have come up with a new property called "color" to describe the force. Each quark flavor can come in three complementary "colors." Only particles that have "color" feel the quark binding force. And strict rules governing "color" combinations determine how quarks bind together to form such particles as protons and give rise to the strong force.

Quarks Stick Together with Gluons

All this is pulled together in a theory called quantum chromodynamics (QCD), analogous to the thoroughly-proved quantum electrodynamics which describes the interaction of particles through electromagnetic forces. According to QCD, the "color" force should be mediated by a particle called a gluon (the glue that sticks quarks together) just as the electromagnetic force is mediated by the photon. This particle, the gluon, now may be showing up in experiments. Finding unambiguous evidence for it would be strong, albeit only partial, confirmation of QCD.

What physicists are looking for (especially in electron-positron collisions) are patterns in which debris shoots out in jets. Some events involving gluons should produce two oppositely directed jets that become increasingly thin and pencil-like as the collision energy increases. Double jet events observed over the past five years do support QCD predictions, according to F. E. Close of Britain's Rutherford Laboratory in *Nature*. Sometimes one of the jets should fan out so that the two jets together look like a tennis racket. Physicists from the Deutsches Elektronen-Synchrotron (DESY) at Hamburg reported evidence for such events last June.

But the main excitement this year involves events in which three jets form a pattern like the three-pronged star on Mercedes cars. Such events were reported by DESY experimenters at an international conference at the Fermi National Accelerator Laboratory (Fermilab) outside Batavia, Ill., last August. They appeared in early experiments using a new DESY electron-positron colliding beam storage ring called PETRA. As Dr. Close notes, the PETRA events were mainly of the two-jet type with a number of "tennis rackets" some of which "do appear to be resolvable into a genuine three-jet structure." This suggests but doesn't prove that gluons are involved. Dr. Close summed up the situation by saying, "it appears that, at least qualitatively, the behavior of high energy electron-positron annihilation does mimic the expectations of QCD . . ."

As the PETRA experiments continue, and as other new facilities such as an electron-positron colliding beam ring at the Stanford Linear Accelerator Center (SLAC) come on line, more evidence of gluons is expected. Added to the mass of evidence for the quarks themselves (including new signs of the bottom quark reported by CERN in the summer), this trend of discovery encourages confidence in the essential rightness of QCD.

This is matched by growing confidence in a parallel theory concerning the weak interaction, a theory which unites the weak force with the electromagnetic force. The 1979 Nobel prize for physics, awarded to Sheldon L. Glashow and Steven Weinberg of Harvard University and Pakistani physicist Abdus Salam, recognizes the significance of this development and of the concepts underlying it. Drs. Weinberg and Salam have devised a model that can predict results so far tested in accelerator experiments. But as Dr. Glashow pointed out, the Nobel prize committee "took a bit of a chance" because "the most exciting predictions haven't yet been verified."

These predictions include the existence of new particles so massive they couldn't be expected to appear at the energies so far available to physicists. But some of the new machines should do the job. PETRA reaches the lower part of the range as far as collision energies are concerned.

Toward International Collaboration

Tantalized by this prospect of possibly confirming major new theories of matter, it's little wonder that physicists feel impatient with the delays, discussions, and budgetary restraints that prevent moving full speed into the new world. While they are getting some new machines, these are slow in coming and questioned intensely by governments that must pay for them.

Unfortunately, the feelings of deprivation have led to an excessive sense of rivalry and a desire for public image building. This showed up last August when overstated reports and comments to the press at the Fermilab conference led to a rash of news stories announcing that the gluon had actually been discovered. Professor Samuel C.C. Ting of M.I.T., who heads a team at DESY, subsequently remarked at a seminar, "I think the *New York Times* proved there were gluons — or some spokesman from Fermilab." Later M.I.T. issued a press release giving credit for the findings to the "M.I.T. group led by Professor Ting" at Hamburg, although it did note there were 57 physicists from seven nations (including 30 from China) in that group.

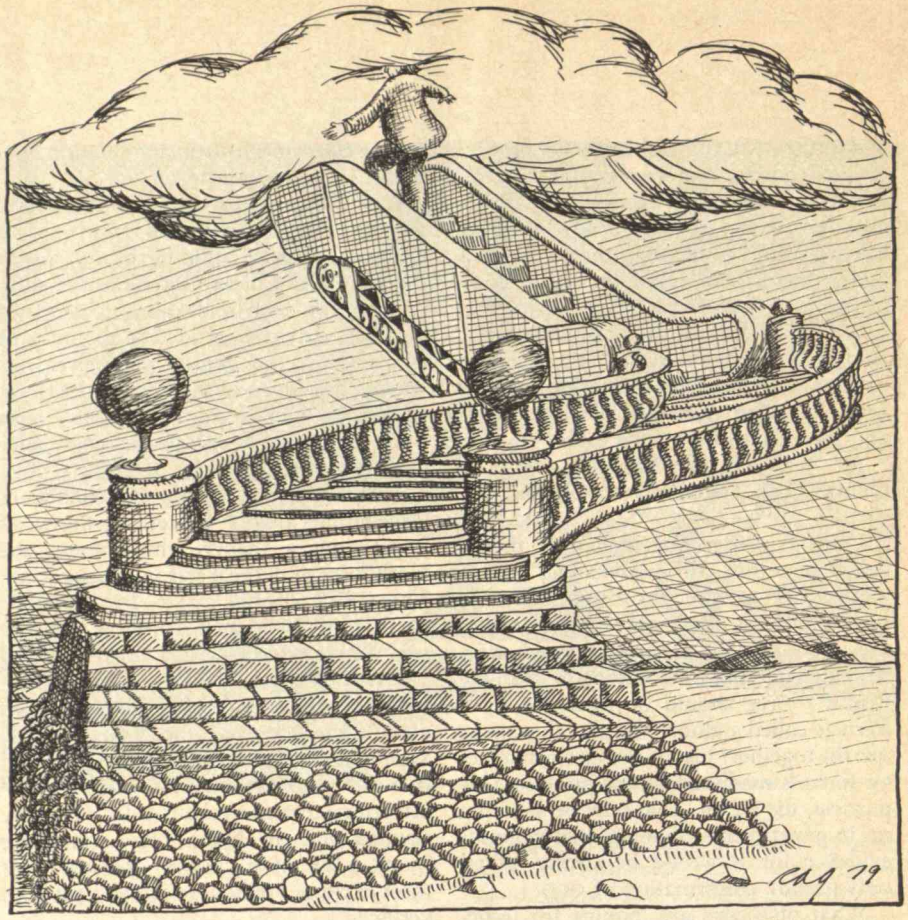
Resentful of such immodest credit taking and overstating of the results, European physicists, according to *New Scientist*, accused the Americans of trying to bolster their image to gain better funding. Some of the Americans, noting that the Germans had encouraged their own press coverage, returned the compliment. According to *Science*, some Americans made no secret of their disappointment that a machine similar to PETRA now being completed at SLAC had been delayed by low funding — a circumstance that let DESY beat them in finding the first three-jet gluon events.

This scrambling after "image" and credit is foolish and counterproductive. It reinforces a false public impression that physicists want to spend money on expensive "toys" to satisfy their egos — an impression some of the budget-cutters in governments are all too eager to promote. Physicists should face the fact that the successes which have brought them to the brink of exciting breakthroughs have also created a need for research facilities that no one nation can really justify, given the competing demands on resources expected for the 1980s. It's time to consider seriously the long-discussed international accelerator center — one that would include the United States and the Soviet Union, as well as European and Asian nations. Countries with accelerators have generously allowed foreign scientists to use them. But such centers are becoming too costly for this kind of arrangement.

Here, CERN provides both a model and encouragement. Rising from the ashes of World War II, it first brought former enemies together and now includes Russian, American, and Chinese physicists as well. It is a highly successful concern that, as M.I.T.'s Victor Weisskopf — a former CERN director — has put it, fulfills the dream of "a great and active laboratory of fundamental physics in Europe that transcends national boundaries and is a symbol of a bright future, when humanity will be united and when national pride does not refer to any specific country but to the whole of our great planet Earth." If that sounds idealistic, think first of CERN's success in Europe. Consider secondly that it may well take the resources of many nations, if not the entire earth, to pursue high energy physics into the energy ranges it is leading — a search for knowledge that, after all, is being developed for all mankind. □

Innovation: The Next Step

William D. Carey is administrative officer of the American Association for the Advancement of Science and publisher of Science *magazine. This essay is based on remarks prepared for a symposium on industrial innovation arranged for the 1979 annual (fall) meeting of the American Chemical Society by its Division of Industrial and Engineering Chemistry and the Industrial Research Institute, Inc.*



Richard A. Goldberg

A good friend of mine who is now the president of Ohio State University once gave a speech entitled: "On a Clear Day You Can See Practically Nothing." I wish I had thought of it first, for the title aptly describes the difficulty in predicting the future of technological innovation.

If we look closely at our policy-making system in the United States, testing for signals in response to evidence of a troubled technological enterprise, we come up with very little. Studies are piled upon previous studies. We have a presidential call for a new surge of innovation. We have Congressional hearings and volumes of expert testimony. We have government and private-sector reports which try to diagnose the pathology of the noninnovating environment. There is, however, unmistakable concern in the executive branch of government to find a credible policy route — and a politically workable one — to deal with the issues.

A fundamental question is whether the issue of lagging innovation really lends itself to systematic and sustained policy treatment by government in the present unsettled climate. My sense is that there isn't enough political capital in the issue to generate wholehearted action. Although the issue is an economic one, the obvious problems currently preoccupying policy managers are intransigent inflation, recession, government spending, an overloaded credit structure, and sinking productivity. It is almost too much, in the face of these parallel calamities, to expect policy makers to converge on the innovation issue as a major element in either the overall economic problem or its solution. How can we seriously expect that a government that has been stymied with the energy question for six years could easily put together a new and stable long-term policy climate to encourage innovation?

Political Timing

Part of the situation, I tend to believe, is that the policy makers recognize elements of sharp domestic discord in a comprehensive program to get innovation back on the track. Aside from the doubtful outlook for sizable corporate risk ventures in the near-term climate of scarce and expensive venture capital, we have to recognize that the politically volatile issues of regulatory rollbacks or moratoria, tax arrangements that appear to favor business, and an easing of antitrust policies all tend to be unappealing on the eve of a national election. Timing is anything but a neutral factor in launching policy innovation.

Going further, I think we may have to concede that it will not be easy to demonstrate or to monitor the effectiveness of any specific policy shift on the process of technological innovation, especially in the initial years. All of the possible government policy changes that have been talked about would crosscut managerial judgment, market opportunity, competitive forces in play, and externalities. Whether innovative performance in industry picks up because of — or in spite of, or regardless of — public policy actions, or is due instead to the successful private management of market forces, would be devilishly hard to pin down. The dynamics of innovation are studied and preached at length by our friends in the business schools (and I am an avid reader of their outputs), but what it actually comes down to is that there's little we can be sure of. (That in itself may be a good thing, because if we ever figured it all out we would probably louse it up.) The point is that almost any broad menu of governmental policy fixes to the innovation syndrome would have to be advocated and argued largely on faith rather than certainty, and this is no small obstacle to getting policy action.

Policies in Search of Advocates

I have just alluded to advocacy, and it was intentional. There has to be a powerful and convinced advocate for a strong set of policy changes, particularly where these would require legislation or trigger public-interest controversy. In turn, the best of advocates must be backed up by a strong and unified constituency because if anything is certain it is that opposition would be mounted by other constituencies which would be strong and unified. Do any of us think we see a constituency straining at the gates to cheer on the advocate for innovation-related public policy changes? Big policy changes — and they are all that matter, not just futile tinkering at the fringes of the problem — call for a

(Continued on page 86)

New Hope For Energy Conservation?

The U.S. still imports almost half its oil. New incentives for conservation may finally help reduce this dependence.

Conservation is the only near-term strategy that could reduce America's dependence on imported oil. But as Anthony Lewis, columnist for *The New York Times,* observes, "Conservation is not a politically sexy idea. It cannot be described as a 'massive' program, a new Manhattan Project. It does not make Presidents sound bold." In short, conservation lacks a clear constituency.

Conservation doesn't have to mean sacrifice.

The failure of conservation to attract a constituency may result from the sacrifices Americans have been asked to accept in the name of conservation.

This is unfortunate, because conservation actually describes the process of getting more for less, or improving the efficiency with which energy is used. Daniel Yergin, co-editor of *Energy Future* (Random House, 1979), said it all when he termed the President's program mandating thermostat settings a major setback for conservation. After all, who wants to be too cold in the winter and too warm in the summer? Yergin and other analysts believe that if energy efficiency became a way of life, Americans could live as comfortably as they do now on 30 to 40 percent less energy.

New incentives need support.

The Senate recently approved important new incentives for residential and commercial conservation and the House of Representatives is likely to consider similar measures soon. It may be premature to claim that a long-overdue constituency for conservation is finally taking shape. But Congressional action on the new incentives may suggest that more Americans than ever before are willing to look from their attics to their basements for the "new" domestic energy the nation needs.

Conservation opportunities also abound in industry, which has already improved its energy efficiency by 16 percent since 1973. But like homeowners and commercial property owners, industry often lacks the capital or finds the payback (in fuel savings) too long to invest in many of the conservation projects that could be undertaken. Congress should extend the principle of financial incentives to industry, because conservation is the best near-term energy strategy the nation can pursue.

For a copy of a paper on conservation incentives presented to the Conference Board by Ronald S. Wishart, Union Carbide's director of energy policy, write "Conservation," Union Carbide Corporation, Box G-25, 270 Park Avenue, New York, N.Y. 10017.

UNION CARBIDE

Toward an Enlightened Policy for Tropical Forests

Jim Talbot is a tropical biologist who received his Ph.D. from the University of Southern California in 1976. He is presently a staff officer in the Division of Biological Sciences of the National Research Council. The opinions expressed in this column are his own.

Our remaining tropical rain forests — some of the world's most valuable resources, located chiefly in the Amazon Basin, Central America, Indo-Malaysia, West Africa, and the Zaire Basin — are in serious danger. Unless the ongoing deforestation is controlled, these forests may be decimated within the next 30 years. With them will disappear the thousands of species of plant and animal life they harbor. And the extent of these consequences for medical and pharmaceutical research, soil productivity and erosion, the global hydrologic cycle, and the carbon dioxide balance are still being investigated.

The causes of destruction vary from region to region, but in general they involve pressure from agriculture, the timber trade, cattle ranching, and firewood gathering. Economic incentives lie at the heart of this destruction, most of which occurs in developing nations.

The Players and the Play

More than a decade has elapsed since scientists at the Conference on the Ecological Aspects of International Development (in December, 1968) first pointed out the hazards of socioeconomic development without ecological considerations in tropical countries. Yet destruction of tropical forests continues unabated. Developers tend to view these scientists as troublesome meddlers impeding local progress. Thus, almost nothing has been accomplished to halt the transformation of tropical forests into cattle pastures, agricultural plots, and "red deserts."

There are a few enlightened exceptions, such as community afforestation programs in China, India, and South Korea, and watershed reforestation in Costa Rica and Panama. But we urgently need a sound general scheme for managing tropical forests that is consistent with both ecological principles and the goals of local countries for developing their natural resources.

In general, tropical countries seek socioeconomic development to improve the quality of life for many of their citizens, and such natural resources as rain forests are often important tools in this effort. But the developing nations are "underdeveloped as a consequence of the development of the rich nations, [which] are founded on the underdevelopment of the former and are sustained by it," in the words of Jack Westoby, a former director in the U.N.'s Food and Agriculture Organization. Ward Morehouse, president of the Council on International and Public Affairs (a private, nonprofit organization), suggests that the U.S. government fosters such business practices by taking a "neutral" position toward the commercial transactions of U.S. and multinational companies in underdeveloped countries.

Timber corporations, for example, encourage tropical countries to export whole logs to the United States and Western Europe for processing when the individual countries could process the logs themselves to their own economic benefit. (Some developing countries now require that saw mills and other processing facilities be built in their own countries before granting timber rights.) Other examples of tropical forest abuse include the cutting of large tracts of forests in the Far East by Japanese paper companies (mostly for toilet paper), and forest clear-cutting in Brazil by Volkswagen to create cattle pasture for its beef export business. Little if any thought has been given to the long-range effects on the welfare of the developing nations.

National Goals Come First

An effective program for saving tropical forests should complement the legitimate economic goals of the tropical countries. Unfortunately, these goals often involve the development of forest resources to generate revenue for other governmental programs. Such development can satisfy environmental concerns if it is oriented to a sustained yield and if the constraints of tropical forest ecosystems are understood, which they usually are not. Indeed, techniques for managing forests on a sustained-yield basis have only recently been developed for temperate-zone forests, and these have generally not been transferable to tropical ecosystems. Tropical forestry

Slash-and-burn agriculture — the clearing of land that can sustain crops for only a few years before new land must be cleared (here shown in the Santa Rita Ridge in Panama) — accounts for the destruction of approximately 100,000 square kilometers of tropical forest each year, according to Dr. Norman Myers, an independent conservation scientist from Nairobi, Kenya. Timber harvesting, firewood gathering, and conversion of forest to cattle pasture are other causes of deforestation in the tropics. Unless effective alternatives are found, most tropical forests could be gone by the end of this century. *(Photo: ALS Lifelines, June, 1979)*

science and appropriate management techniques must be developed through studies of tropical forests.

Management techniques that could be adopted by a tropical developing country include:

☐ A strong declaration that tropical forest development should proceed along *rational* lines — considering ecology, institutional capabilities, industrial forestry projects, and rural development.

☐ Creation of adequate financial resources (perhaps through loans from the World Bank and other international lending agencies) for development of tropical forestry science and management systems.

☐ Feasibility studies and biological inventories of forest resources to determine their quantity (including plant and animal inhabitants) and quality using ground surveys, faunal and floral collections, and remote sensing devices.

☐ Local legislative action to designate appropriate forest uses, with guarantees of restricted areas and land for developers. Paraguay's model land forest law provides for three types of forests: production, protected, and special-use (scientific, educational, and historic).

☐ Harvest of a variety of products such as trees, medicinal plants, and wildlife according to a predetermined schedule to protect against the collapse of any one industry, and to provide benefits for a large segment of the local population.

Together in the Tropical Classroom

Forests reserved for scientific use will permit better understanding of tropical forest ecosystems — including primary and secondary productivity, plant-animal interactions, and, of course, sustained-yield forestry. Tropical countries will obviously need to develop certain technical skills, and developed nations can help by training local scientists. Working together in the tropical "classroom," developed and developing nations may begin to understand the real meaning of cooperative research — sharing, not transfer, of knowledge — and may therefore develop technologies appropriate to individual countries.

This model assumes that developing countries are ready to embrace the rational management of forest resources. However, most tropical nations will move slowly toward this goal because of inadequate development funds, poorly defined national goals, and strong resistance from commercial interests of developed nations. The governments of the more enlightened developed countries can help by:

☐ Trying to influence the business ethics of their companies.

☐ Promoting increased understanding of tropical environments.

☐ Transferring technologies that will lessen rather than add to the developing countries' problems.

☐ Providing information on ecology to their decision makers and investors.

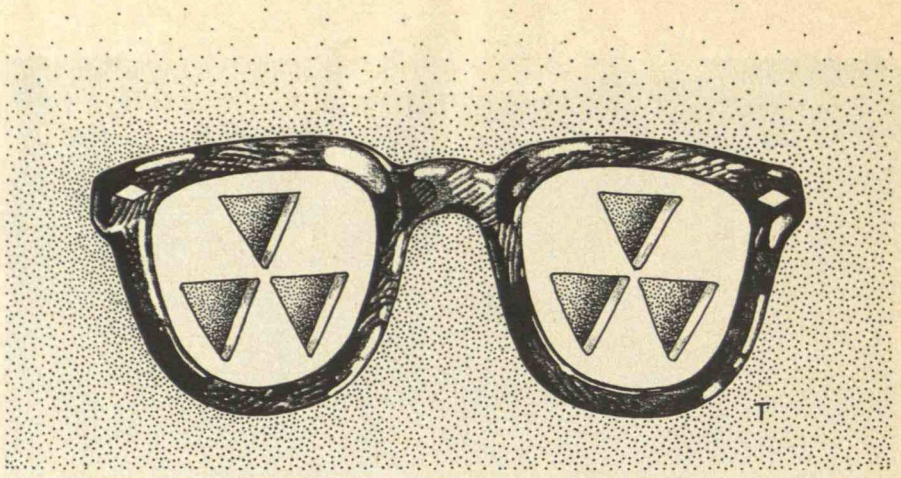
A word of caution is needed. There is a tendency among developed nations to offer "economic miracles" to developing nations. Claude Alvares, the director of the Rural Study and Transformation Center in Goa, warned against so-called "development" projects that have done more harm than good to the developing nations. Examples are the Tarbella Dam project on the Indus River in Pakistan, iron ore mining in Goa by Japan and Germany, and the counterproductive "green revolution."

The United States is presently formulating a long-overdue policy on tropical forests. Let us hope that it strongly considers the long-term interests of the developing nations. ☐

A Bible for the Antinuclear Movement

No Nukes: Everyone's Guide to Nuclear Power
Anna Gyorgy and Friends
Boston: South End Press, 1979, 478 pp.; $8.00 (paper)

Reviewed by Robert Cameron Mitchell



Ted Sillars

In common with other quality-of-life movements in the U.S., the antinuclear movement is a complex, sometimes bewildering array of groups and individuals who are united by a common goal but whose conceptions of tactics, issues, acceptable compromises, and ultimate ends are as varied as those of the Protestant reformers of the 16th century.

The newest and most dynamic segments of the antinuclear movement are the numerous local and regional groups dedicated to civil disobedience that emerged as clones of the Clamshell Alliance following the Clam's initial actions at Seabrook, New Hampshire, in the summer of 1976. Deliberately eschewing hierarchy, and suspicious of those who want to claim leadership or impose an ideology on the movement, these groups nevertheless share a unity of purpose about the nature of the evil they fight and the future society they prefer.

For someone who wants to understand just what all those clams, crabs, abalones, catfish, palmettos, and other curious creatures are after when they clamber over fences at nuclear power sites, hold candles in vigils outside the Nuclear Regulatory Commission's offices, and campaign for a referendum to ban the transport of nuclear waste through the streets of their communities, *No Nukes* is, to paraphrase the bumper sticker, "good nukes."

Longtime Clamshell activist Anna Gyorgy and her collaborators have assembled a handbook that discusses in a remarkably coherent fashion the movement's case against nuclear power, its proposals for an alternate energy path, and the evolution and present status of the movement in other countries as well as in the various regions of the U.S. It may well become — as one activist recently described it to me at Seabrook — the movement's bible.

Like the Bible, the book is lovingly written in clear, simple language by many hands, uses exposition far more than exhortation to convert the unbeliever and to inspire the already converted, and is remarkably undoctrinaire — albeit one-sided — in its promotion of a revolutionary world view.

All too often the antinuclear movement mistakenly is dismissed as yet another simpleminded attempt to repeal technological progress. Yet when viewed in a political context, *No Nukes* clearly shows that the leadership of the Clamshell and its allies do not oppose technology per se. Just as Jesus declared that he came to fulfill the law and not to destroy it, so they seek the transformation of the present form of energy technology into another form of technology that they believe will better serve human needs.

A Bible with Numbers

Unlike the Bible, however, *No Nukes* is filled with technical exposition, charts, maps, drawings, cartoons, a glossary, footnotes galore, and lists of books, pamphlets, and organizations to contact for further information — a plethora of resources worthy of the generation that originated the teach-in and created the *Whole Earth Catalog*.

This technical exposition serves three purposes. First, *No Nukes* describes how nuclear reactors work, the nature of the nuclear fuel cycle, and radiation effects on the premise that "for your own protection, we *have* to understand [nuclear power's] basic principles" (emphasis in the original). Second, the book presents a detailed indictment of nuclear power's failings in an effort to show that "extreme risks to health and safety are an inherent feature of nuclear power" and that it is an uneconomical source of energy once its many "hidden costs" are recognized. And third, the book describes alternatives to nuclear power. Almost one-fifth of the book is devoted to describing the technologies of recycling, coal, nuclear fusion, and, especially, conservation and solar energy. A combination of solar and conservation is said to be equal to the task of providing enough energy for continued economic growth and prosperity *and* for promoting the necessary societal shift from reliance on large, complex, centralized energy systems to those that are "decentralized, accessible, understandable, and available for local control."

Here we come to the heart of the matter: what really motivates many antinuclear protesters is the belief that nuclear energy is not only unsafe, but inhumane. *No Nukes* teaches that nuclear technology inevitably promotes the domination of the economy by large corporations, the production of energy at prices that are higher than people can afford, the continuance of a permanent war economy, the proliferation of nuclear weapons, the alienation of individuals from the technology that sustains them, an exploitative attitude toward nature, the centralization of societal institutions at the expense of local communities, and the development of social control along the lines of a police state.

No Nukes Means No Nukes

Nuclear energy is said to have these deleterious consequences and more because it is a "high" technology, and the authors of this book oppose high technology in all its forms, including the solar power towers and solar satellites. "Low" technologies are said to be the only way to fly. Likewise, while giant corporations are viewed with extreme suspicion, small businesses are apparently all right. The same criteria of size and local control are also applied to governments, with municipal governments receiving high marks as potential suppliers of reasonably priced energy to their constituents.

The book's snappy title and this brief

description of its approach may suggest that *No Nukes* is strident and aggressively ideological in its criticism of society. Not so. While uncompromising about nuclear power — "no nukes" means just that, not "no more nukes" or "safer nukes" — the book's tone is low key and its arguments based on the premise that a reasoned analysis based on solid evidence is the best way to convince people of the unacceptability of nuclear power.

No Nukes is a far cry from being "everyone's guide to nuclear power" as its subtitle proclaims. But that is to be expected from a book whose preface forthrightly proclaims its purpose to be the presentation of the "other side" of the argument. The book serves this latter purpose very well and in so doing makes a valuable contribution to the nuclear debate.

Robert Cameron Mitchell, Ph.D., is a sociologist and senior fellow at Resources for the Future, a nonprofit Washington-based research institution. □

"An Almost Incomparably Toxic Substance"

The Pendulum and the Toxic Cloud: The Course of Dioxin Contamination
Thomas Whiteside
New Haven, Conn.: Yale University Press, 1979, 205 pp.; $4.95

Reviewed by William M. Hastie

On March 1, 1979, Federal Judge James Harvey, expressing "great reluctance," upheld the Environmental Protection Agency's temporary suspension of most uses of the herbicides 2,4,5-T and silvex. These two products have, in the past, been sprayed on a total of 5 million acres of rangeland, timberland, farmland, highway, and powerline rights-of-way in the U.S. each year, despite the fact that both contain 2,3,7,8-tetrachloro-dibenzo-p-dioxin, otherwise known as TCDD, or simply dioxin. And Tom Whiteside, a veteran environmental writer, in this book and in *The New Yorker* articles on which it is based, calls dioxin "an almost incomparably toxic substance."

Why then should Judge Harvey express such reluctance at upholding the E.P.A.'s long-awaited action? Though *The Pendulum and the Toxic Cloud* is now a year old, it still sheds needed light on this question. After ten years of research on dioxin, the only thing that has become clear is just how little we really know about this substance. Whiteside argues that the tangled scientific controversy surrounding dioxin exemplifies the problems of effectively regulating toxic materials.

Our lack of knowledge, he maintains, is the basis of a sticky scientific problem. No one has been able to verify, at least to Judge Harvey's satisfaction, that low-level dioxin exposure stemming from herbicide use poses a serious threat to health.

This is not to say that dioxin's toxicity is in doubt. Extensive exposure has long been known to cause chloracne, a remarkably persistent, potentially fatal disease characterized by severe acnelike skin eruptions, damage to internal organs, particularly the liver, disruption of the body's disease-fighting mechanisms, and damage to the nervous system. The symptoms often continue for five years, and victims have been known to take their own lives.

Dioxin exposure at lower levels may cause cancer, birth defects, miscarriage, and impotence. It may also cause such psychological problems as depression, nervousness, irritability, loss of sex drive, and insomnia, which are believed to have contributed to chloracne-related suicides. These ailments have repeatedly been cited in a class-action suit brought against Dow Chemical (a large producer of 2,4,5-T and its precursors) by Vietnam veterans who were exposed to Agent Orange, the army's name for the 2,4,5-T it dropped on millions of acres of that battered country. A Vietnamese public health official has found these same effects among his own people.

A minor flood of animal studies has found birth defects and miscarriages following dioxin exposures in food as low as 10 parts per trillion, and death at only 50 ppt. Nonetheless, there have been to date no undisputed studies linking such effects to low-level dioxin exposure in humans.

The E.P.A. based its suspension order on a study that found an increased rate of miscarriage among women in Alsea, Ore., soon after the use of the herbicides on nearby timberlands. Epidemiological studies linked the suspected level of exposure to the observed frequency of miscarriages. But this study has been bitterly disputed by the chemical industry, and Judge Harvey also called it suspect.

Researchers were unable to establish conclusively that dioxin was (or had been) present in the bodies of women suffering miscarriages, and they could only suggest paths by which dioxin might have reached the women. Despite these weaknesses, the E.P.A. found the evidence sufficient for a temporary suspension.

Industry scientists have shown that dioxin is broken down by sunlight and soil bacteria and that it is nearly insoluble in water. Therefore, dioxin in the soil does not readily leach into the environment. On this basis the industry maintains that, when used according to instructions, the minuscule amount of dioxin present in the herbicides is so diffused by the spraying operation that any dangers to human health are inconsequential.

In preparation for hearings this fall aimed at an outright ban on the use of 2,4,5-T and silvex, investigators checked soil, water, and animal life in the Alsea area for traces of dioxin to prove its presence during the critical period and close the case on this chemical. However, incontrovertible evidence has proved elusive, for reasons Whiteside illuminates in *The Pendulum and the Toxic Cloud.*

Stripping Leaves, Trees, and Topsoil

Much of the book is devoted to analyzing a 1976 chemical factory explosion in Seveso, Italy, which released a cloud — heavily contaminated with dioxin — that settled over the town. But even a disaster of this dimension has provided little good scientific information on dioxin's health effects.

The behavior of the townspeople varied widely — some were terrified, while others scoffed at the invisible danger and reentered the evacuated zone repeatedly. Frightened by the possibility of birth defects, many women had abortions, and in this heavily Catholic country many of these were kept secret or listed as spontaneous by sympathetic doctors. Such problems make studies of the health effects of toxic pollutants on the population difficult to conduct, harder to interpret, and easy to dispute. Indeed, health studies from Seveso may be virtually worthless. Still, the disaster extends beyond direct health effects.

For instance, political considerations led officials to draw arbitrary borders to the contaminated zones. The government failed to close parts of a major highway that were closer to the offending factory than some portions of the town that were evacuated for safety reasons. Mistakes and outright abuses were rampant in the clean-up effort. Whiteside reports, for example, that after cleaning contaminated houses workers dumped waste water into sinks and bathtubs. It then flowed into the

(Continued on page 89)

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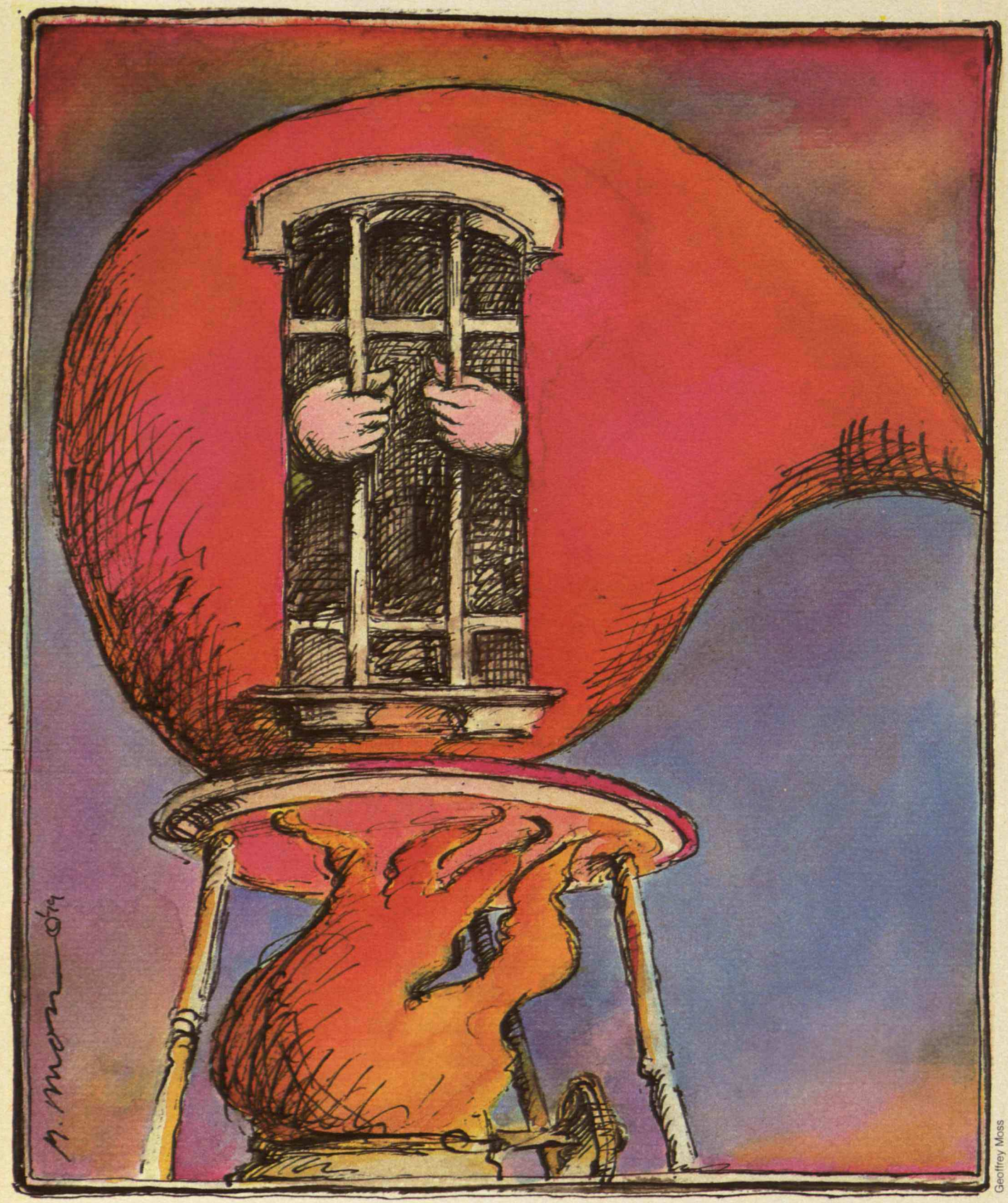

Geoffrey Moss

Science and Human Rights

by
Earl Callen,
Bernard R. Cooper,
and John Parmentola

Historically, scientists have been reluctant to involve themselves in human rights issues. But the role of scientist-as-freedom-fighter becomes more palatable when people realize "science" cannot exist independent of "scientists."

Yuri Orlov, sentenced to seven years of hard labor and five years of "internal exile" for publicizing Soviet violations of the Helsinki Accords, is a particle physicist. Anatoly Shcharansky, sentenced to thirteen years of hard labor for human rights actions, is a mathematician and computer scientist. Andrei Sakharov, leader of the Soviet human rights movement, is a nuclear physicist. The father of the Soviet hydrogen bomb, Sakharov was awarded the Lenin Prize and the Stalin Prize, was three times "Hero of Socialist Labor," and is a full member of the Soviet Academy of Sciences. These awards were all conferred for his scientific research before his advocacy of human rights.

Other activists have been physicists Valery Chalidze, Pavel Litvinov, Naum Meiman, Sergei Polikanov, Valentin Turchin, Andrei Tverdoklebov, and Iosif Zisels; biologists Sergei Kovalev and Zhores Medvedev; and the mathematician Leonid Plyusch. Even writer Aleksandre Solzhenitzyn has had techical training. In *The First Circle* Solzhenitzyn recounts his prison experiences as an electronics technician in an acoustics and telephone communications "sharasha" (special scientific laboratory) of the Mavrino Special Prison outside Moscow.

Science and human rights — in fact science and activism of any sort — seem unlikely partners. How can we explain the preponderance of scientists among Soviet human rights activists — numbers too great to be explained by coincidence? Is it due to the example of the great Sakharov? Or is it something peculiarly Russian? Scientists are supposed to be thing-oriented, introverted, lost in *gedanken* experiments in their ivy-covered monasteries. Human rights is supposed to be the domain of the other culture, the humanists.

This article attempts to show that the role of the scientist as freedom fighter is not as alien as it seems. We shall describe the evolution of a commitment in the American science community — widely shared and growing, albeit of a lesser intensity than that of the beleaguered Soviet reformist comrades. In particular, we shall describe the evolution of social consciousness in the American physics community and in its professional organization, the American Physical Society.

To the scientist, the search for understanding is a flight of the spirit. To fly free one must *be* free. Long before President Carter made human rights fashionable, and long before other professional societies had begun to discuss the propriety of social action, natural scientists and their societies were forming human rights committees and were petitioning, pro-

"Individual
oppressed scientists,
especially in the Soviet Union,
have led the evolution of social consciousness
in the scientific community."

testing, and boycotting.

Today more than ever, scientists are involved in world affairs. Two of us (Cooper and Parmentola) traveled to Moscow last February. Two months earlier we tried to attend an international conference organized by "refusnik" scientists — Soviet scientists, mostly Jews, who want to emigrate and have been denied that right, fired from their jobs, and persecuted for the attempt. For more than six years the refusniks have held weekly Sunday afternoon seminars in Moscow to maintain their scientific capabilities. (The seminar is known in Moscow as the "nonexistent seminar.") A similar, smaller seminar is held in Leningrad on Monday evenings. The refusniks have also organized three international conferences, held, like the weekly seminars, in various Moscow apartments. We had originally applied for tourist visas to deliver papers at the third of these international conferences. As they had before, Soviet authorities tried to prevent the conference from taking place. Agents of the K.G.B. (Soviet secret police) raided the apartment of Victor Brailovsky and confiscated scientific papers and a slide projector. Soviet participants were warned not to attend or they would suffer prosecution. Our visas were canceled by the Soviet embassy just as they were delivered to the New York tourist office.

Of eight Americans who received tourist visas to attend, five had them rescinded. The other three went to the Soviet Union under the guise of group tours, and struck off on their own when they got to Moscow. (This third international conference was actually the second. No Western delegate received a visa from the Soviet government to the first conference in 1974, and its Russian organizers were imprisoned.)

But the regular Sunday refusnik seminar continued to meet each week, so when we obtained tourist visas in February, we went to Moscow and to the seminar. By chance we arrived on the fourth Sunday of the month, reserved as "humanities Sunday." Our talks on elementary particles and on the magnetic properties of solids followed a lecture by Solomon Alber, the mathematician and self-taught lawyer asked by the Shcharanskys to defend Anatoly Shcharansky at his trial, a role the Soviet authorities forbade. That Sunday at the seminar in the Brailovsky apartment, we heard Alber describe, for the first time openly in the Soviet Union, the maneuvers, the fabricated evidence, the arbitrary procedures, and the transparent illegality — even by Soviet judicial standards — of the Shcharansky trial.

The Old Order: Science, Not Scientists

Individual oppressed scientists, especially in the Soviet Union, have led the evolution of social consciousness in the scientific community. For years Andrei Sakharov spurred us on. In 1975, charges by Yuri Orlov that international scientists, and especially the American National Academy of Sciences, could do much more, helped force that once-reticent body into a more aggressive stance. For scientists have not always been involved in human rights. Forty years ago during the Nazi regime, when many persecuted scientists were well-known and often personal friends and colleagues as well, the American scientific community took no stand. Those were problems of *scientists*, not *science*. The scientific ethic of the time was that, whatever his or her political and social beliefs, the proper scientist remained silent. We possessed neutral skills and knowledge independent of values, we served science and society best by providing objective expertise without ideological trappings. It was a misrepresentation to use platforms gained by professional eminence to espouse causes into which our special but limited skills gave us no insight.

This was the prevailing view, but of course not all scientists subscribed to it. A notable exception was Albert Einstein, who took a political stand long before he himself became a victim of Nazi persecution. Einstein never hesitated to take positions on pacifism, Zionism, racism, and human welfare. In 1914, at the outbreak of World War I, the German government issued the "Declaration to the Cultural World," which declared that "German culture and German militarism are identical." Patriotic hysteria was such that not signing the declaration was viewed as tantamount to treason. Of Germany's in-

tellectual leaders, only Einstein and David Hilbert, the great mathematician, refused to sign. Then, in 1946, only 10 years after coming to the United States, Einstein wrote of American racism: "The more I feel an American, the more this situation pains me. I can escape the feeling of complicity in it only by speaking out." But Einstein was not a joiner. Though revered for his scientific genius, he was not a member of the scientific or political establishments. In the 1930s and 1940s, the leadership of the scientific societies was conservative, and it — not Einstein — set the tone.

What was deemed proper for the individual scientist was even more appropriate for professional associations. For example, the constitution of the American Physical Society states that, "The object of the society shall be the advancement and diffusion of the knowledge of physics." From the founding of the A.P.S. in 1899 until the past decade, "physics, not physicists" was the shibboleth of the society, as if physics was something that existed in and of itself, rather than as a human activity. This view was a barrier to every human rights initiative. The A.P.S. published technical journals such as *The Physical Review*, organized scientific meetings for the dissemination of research results, elected largely honorific officers, and did little more.

The first significant step, one of philosophical importance not recognized at the time and one that came from the society leadership, was the initiation of a placement service. The placement service, a secondary activity of large technical meetings, helps match employers and job applicants with one another. The organizational role of A.P.S. is passive and the cost is small, but this function was that first recognition that *physics* is advanced and diffused by *physicists*.

Perceptions of science as a human activity have percolated slowly and far from completely into the consciousnesses of working scientists. Because of the rapid progress of science, "generations" can be defined in terms of 10 or 15 years. These generations also represent differences in the development of social attitudes. The evolution to a heightened social conscience among scientists began with Hiroshima, grew with the civil rights movement, and was strengthened during opposition to the war in Vietnam. However, the continuing groping for the appropriate degree of social commitment is complicated by the fact that these events of the past 35 years have had different effects on different generations.

The cataclysm of Hiroshima thrust scientists now in their mid-fifties into awareness of the responsibility for the fruits of their labors. The Federation of American Scientists and the *Bulletin of the Atomic Scientists*, legacies from that era, are primarily concerned with nuclear proliferation and arms control. The primary social influence on scientists currently in their mid-forties was the civil rights movement which, though it had little direct bearing on science, had a great deal to do with scientists.

The American Physical Society has 30,000 members, almost all of whom have Ph.D.'s. A decade ago there were approximately 50 black American physicists with Ph.D.'s, 5 Chicanos, and 1 American Indian. The numbers are better now, but still unsatisfactory. Less than 3 per cent of American Ph.D. physicists are women. Of almost 1,000 Ph.D.'s in physics granted in 1978, 9 went to blacks and 1 went to an American Indian.

At an A.P.S. meeting in March, 1954, at Durham, N.C., there was a mass resolution protesting the segregated dormitories of Duke University in which attendees were housed. The Solid State Division resolved not to meet again without guarantees of integrated facilities. To our knowledge, the society never again met at a segregated hotel or campus.

But it was the war in Vietnam that finally routed "objectivity." For a decade, young scientists observed their elders in supposedly objective, value-free work — developing laser-guided bombs, electronic fences, infrared missile-guidance systems, magnetic mines, and computerized warfare. Attempts to discuss context — "why" as well as "how" — were rejected as inappropriate for a society chartered to advance and diffuse the knowledge of physics (not to consider its social milieu). For the first time, the A.P.S. censored its bulletin.

Today, in marked contrast, members regularly

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discuss social issues at A.P.S. meetings. For example, there have been discussions of the war in Vietnam, the antiballistic missile, supersonic transport, arms control and disarmament, energy, pollution, nuclear reactor safety, nuclear proliferation, appropriate technology, classification of scientific secrets, "whistleblowers," privacy, employment guidelines, the job crisis, and the status of women and minorities. The A.P.S., not without controversy, has resolved to hold its national meetings only in states that have ratified the Equal Rights Amendment.

Back in the U.S.S.R.

The first venture of American scientific societies into international human rights issues occurred in November, 1972. The Soviet Union was then imposing an emigration tax on its citizens, the stated purpose of which was to recover the cost of education provided free by the Soviet Union. This ex post facto tax amounted to approximately $21,000, or about ten years' gross salary, for a Ph.D. Very few Russians have that much money, and if one did save it up, its possession, coupled with a request to emigrate, would probably lead to a charge of black marketeering. Hence the education tax effectively blocked the emigration of scientists and other educated persons.

Letters from A.P.S. members urging action, and a petition circulated among industrial physicists, prompted the society to write to M. Keldysh (then chairman of the Soviet Academy of Sciences) urging a discontinuation of the emigration tax. As far as we know, the A.P.S. was the first scientific society in the United States to take the plunge. With the ice broken, a number of other societies followed. Did this action have any effect? In such affairs, one never knows. But we do know that Henry Kissinger spoke to Leonid Brezhnev about the tax, and it was dropped.

Over the years presidents of American scientific societies have written increasingly strong letters on behalf of the Russian refusniks and dissidents. Academician Keldysh sometimes responded. His successor as president of the Soviet Academy of Sciences, A. P. Alexandrov, has over the years sent only one terse response to many remonstrances. This does not imply that Alexandrov is less sympathetic than Keldysh was, or that our letters are less useful. Even when the Russians respond to American pressure, they take great pains to conceal it. It is a thoroughly unscientific but serious game we scientists are playing.

The 1973 International Conference on Magnetism held in Moscow (*see box page 27*) taught American scientists much more than magnetism. Witnessing fellow scientists barred from an open, unclassified, international meeting — by Soviet soldiers with rifles — raised the consciousness of many Americans, and American scientists have aided Soviet refusniks continually ever since.

Refusniks are not only fired from their jobs; they are often barred from research institutes, colleges, and libraries and are generally shunned by the Soviet scientific community. To help relieve their isolation, the A.P.S. has mailed them gift subscriptions of scientific journals. But the journals and ordinary letters reach the addresses only intermittently. The Congressional commission charged with monitoring the Helsinki Accords has been informed of the irregularity of journal delivery, but that commission has little authority. Journals now being mailed to Victor Brailovsky are being received, but those sent to another refusnik, Yuri Golfand, are not being delivered although registered mail receipts are coming back.

State of Siege

So far we have discussed only the Soviet Union, where there is a continuing number of cases and problems. Several other countries also have severe human rights problems, but the number of cases involving scientists is smaller. The plight of Roger Posados in the Philippines is one example. Posados, a theoretical physicist, returned to the Philippines in 1970 after receiving his Ph.D. from the University of Pittsburgh. He is one of only ten physics Ph.D.'s in his country. As assistant professor and chairman of the physics department at the University of the Philippines, Posados organized a group calling for

"Of the 22 physics faculty members at the University of Santiago at the time of the coup, 2 remain; of the 34 chemists, 11 remain; of the original 45 professors in the natural sciences, 7 remain."

increased funds for science and for educational reform. In 1971, he was branded "subversive" and went into hiding. In January, 1976, Posados, his wife (also a physicist), and their four-year-old son were apprehended and Posados was beaten.

Mrs. Posados was released after five months. The struggle to get Roger Posados released was much longer. Letters to President Ferdinand Marcos and pressure by U.S. officials helped to finally get Posados released from prison in September, 1978. He has now been allowed to return to his job.

Eastern Europe is a problem area. Because of a supposed attempt to visit Vienna while attending a conference in Warsaw, young Romanian scientist Constantin Pomponiu was denied governmental validation of his doctoral degree. Influential members of Congress intervened, using the Jackson-Vanek "most-favored nation" amendment as leverage. Pomponiu was allowed to leave Romania in October, 1978. He has since taken a position at Carnegie-Mellon University.

In Czechoslovakia repression has intensified over the past two years. Physicist Vladimir Lastuvka, in prison since January, 1977, is charged with "intent to sign" Charter 77, a grass-roots petition affirming the Helsinki Accords. Police found copies of Charter 77 and other "anti-State material" in his apartment, and the prosecutor has announced that the scientist was "on the point of signing" the document. Letters of inquiry to the government of Czechoslovakia have not been answered. He is currently serving a three-year prison sentence.

The human rights problems under the many dictatorships in South America are well-documented. Argentina, Brazil, and Chile are of particular concern to scientists because of the large scientific communities in those countries. But perhaps we should use the past tense — in Chile and Argentina scientific communities hardly exist anymore. Politically active Chilean scientists who supported former President Allende fled that country with the coup. Those who remained have suffered. At the University of Chile, the University of Concepcion, Austral University, and the private Technical University of Santa Maria, about 30 per cent of the faculty have been "purged." Of the 22 physics faculty members at the University of Santiago at the time of the coup, 2 remain; of the 34 chemists, 11 remain; of the original 45 professors in the natural sciences, 7 remain.

In Argentina the situation is even worse. The military government under President General Jorge Rafael Videla looks aside while parapolice and vigilante groups, often in uniform and carrying official identification, openly kidnap and murder citizens. Under the "state of siege," in effect since the junta siezed power in March, 1976, the crackdown on leftists has broadened into an attack on all independent intellectual activity. "Intellectual subversion" has been defined as a form of terrorism. Freud and Marx have been branded "ideological criminals" and psychiatrists, psychologists, and mental health workers have been all but wiped out. The entire 140-person staff of the Assistance Centers for Children with Learning Problems was fired. In a press conference announcing the arrest of 17 professors and the "fugitive status" of another 30 faculty members of the National University of the South, General Acdel Vilas, deputy commander of the Fifth Army Corps, proclaimed that "until we can cleanse the teaching area, and professors are all of Christian thought and ideology, we will not achieve the triumph we seek in our struggle against the revolutionary left."

Abduction, solitary confinement, torture, and murder continue to be common in Argentina. A half-million persons have fled the country since the coup. About 40 per cent of the Argentine Physical Society — some 120 physicists, including the former president of the society and almost the entire governing council — have either been fired from their jobs or have fled the country. Military officers run the universities. Many people have simply disappeared; others have been tortured. Many have been murdered in prison. There are secret prison camps at military bases. Few who enter these prisons are seen again.

We note mournfully:

☐ Gabriella Carabelli, a physicist at the National University of Cordoba, was kidnapped with her three-year-old son. She was found dead, her body

doused with gasoline and burned.

☐ Manuel Tarchinsky, a nuclear physicist and professor at the National University of the Sur, Bahia Blanca, was murdered in jail.

☐ Ernesto Silve, professor of chemistry at the National University of Rio Cuarto, Cordoba, was arrested and tortured. Officials explained that Dr. Silve committed suicide in his prison cell.

☐ Eduardo Pasquini, a physicist at the National University of Rosario, disappeared with his wife, a psychologist, on June 10, 1976. Neither has been seen since.

☐ Federico Alvarez-Rojas, a physicist at the Argentine Atomic Energy Commission in Buenos Aires, and his wife Hilda Leikis de Pojas, a computer programmer, were kidnapped on October 1, 1976, and detained by the army. The couple had no known political activities and no charges have been filed. They have not been heard from since their abduction. They leave three young children.

☐ Maximo Pedro Victoria, a physicist at the Atomic Energy Commission in Buenos Aires, was gagged and blindfolded and taken from his laboratory at gun point a week after the coup. On a navy boat at the pier, he was beaten with guns and sticks, and thrown in an isolation cell. On one occasion Victoria and 50 other political prisoners were beaten for one entire day. They were then made to sign statements that their wounds were self-inflicted. Ultimately, seven months after their arrest and still uncharged, Victoria and seven other A.E.C. scientists were released. (Maximo Victoria theorizes that he was imprisoned and tortured because he and his colleagues had argued for the purchase of a type of nuclear reactor useful for research, rather than the type more convenient for the production of strategic nuclear materials the navy wanted to purchase.)

☐ Elena Sevilla, a physics student, was recently released from an Argentine prison where she had been held "for investigation." She is now a graduate student at Cornell. The efforts of people at Cornell were instrumental in obtaining her release.

☐ Daniel Bendersky, a 27-year-old science student, was taken from his home in September, 1978, by four men in plain clothes who claimed to be federal

Reality and the Nonexistent Seminar

A confrontation with reality at the 1973 International Conference on Magnetism in Moscow was probably the single most important spur to human rights activism by the scientific societies. Three members of the Moscow seminar — Mark Azbel, Moshe Gitterman, and Alexander Voronel, all active in magnetism research — were barred from attending the magnetism conference by police at the doors of Moscow State University. This was in violation of the rules of the sponsoring organization, the International Union of Pure and Applied Physics.

To give the excluded scientists a chance to discuss their work, an impromptu session was to be held in Voronel's apartment on Sunday afternoon, August 26. All conference participants were to be invited. But how? A few individuals distributed hand-written announcements in the halls of Moscow State University, posted notices on bulletin boards, and interjected the announcement into their technical talks. The posted notices were torn down, and in one instance, the public address system was cut off in the middle of an announcement. Conference participants were told that the refusnik seminar was to be strictly scientific; no demonstrations or protest speeches would be allowed. Those wishing to attend the seminar would meet and then go together to Voronel's apartment.

The seminar was attended by 41 conference participants from the West, by a number of Soviet scientists (refusniks and others), observers from the official conference organization, and several K.G.B. agents (including one very friendly blonde woman, just like in the spy thrillers).

This was the first participation by Western scientists in the Moscow seminar. Since then, the seminar has had many visitors and speakers from the West. The seminar has continued to be held weekly, often under difficult circumstances, first in the apartment of Alexander Voronel, then of Mark Azbel, and now of Victor Brailovsky, as successive organizers have left the Soviet Union. ☐

"Eduardo Pasquini, a physicist
at the National University of Rosario in Argentina,
disappeared with his wife, a psychologist, on June 10, 1976.
Neither has been seen since."

police and who carried official credentials. Bendersky and his mother were told he was needed for questioning and would be returned that same afternoon. He has not been seen since his arrest, nor has he been charged with any crime. The Argentine government denies knowledge of his whereabouts. Bendersky has been admitted in absentia as a graduate student at M.I.T.

☐ Alfredo-Antonio Giorgi, a 33-year-old chemist and physicist who headed the plastics research laboratory of the National Institute of Industrial Technology, was working in his lab on November 27, 1978, when he was called to the administrative office of the institute. He was confronted by five armed men, claiming to be police and bearing papers, who charged Giorgi with a drug violation. Giorgi was taken away and has not been seen again. His whereabouts are unknown. The ministry of the interior, federal police, and joint military command all deny having arrested Giorgi, and there are no charges against him.

☐ Antonio Misetich, a physicist formerly of M.I.T., was arrested by police on the night of April 19, 1976, and imprisoned without charges. Initially his detention was acknowledged by the Argentine Embassy and by the Argentine A.E.C. Later, the government of Argentina claimed that the original acknowledgement was an error, and that Misetich is not and never has been in custody. Misetich has not been seen since his arrest. Numerous letters have been sent to President Jorge Videla about Misetich and others, but no answers have been received. Delegations of physicists have twice visited the Argentine Embassy in Washington. The American ambassador to Argentina and the U.S. State Department have tried to help, with no results.

The Argentine Assembly for Human Rights has documented more than 4,500 such disappearances since the coup. The United States Embassy in Buenos Aires, under President Carter, has been as forceful as its limited leverage allows. (This was not the case under the previous administration.) The Catholic Bishops of Argentina have been helpful, but the United States business community in Latin America, which could be an effective force, has not been. In December, 1976, eight months after the Videla coup, with daily evidence of disappearances, beatings, and torture, the American Chamber of Commerce in Argentina issued a statement that said, in part: "Faced with social, political, and economic collapse, the military stepped into government to reestablish law and order. This was done without bloodshed and without personal ambitions on the part of the men, military and civilian, who stepped into this extremely difficult situation. . . . The present government in Argentina is the most promising that the country has seen since the overthrow of Peron in 1955. This government's goal is to establish a serious republican democracy. Meanwhile, the terrorist strategy continues to be one of thwarting the government's efforts by every means possible, including negative propaganda abroad."

We suppose that makes us terrorists when we ask what has happened to Antonio Misetich and the 4,500 other "disappeared persons," including at least 22 children.

Are Scientists Special?

We have presented a brief history of how scientists have recognized, individually and through their professional societies, the tie between the protection of human rights and the progress of science. But attitudes don't change overnight, and social awareness among scientists is continually evolving. One question we have had to grapple with is "Why are we making a special fuss about scientists?" Is it because of an arrogant assumption that scientists are more important than others? Philip Handler, president of the National Academy of Sciences, has remarked that "tortured shoe makers hurt quite as much as tortured scientists. Protesting only for scientists doesn't quite fit with my own beliefs about all of this. Scientists happen to be a little more visible. The world knows about them. The shoe makers are taken off behind the barn and shot."

We hope that the honest answer to this disturbing question is that we act in aid of scientists because we are scientists. They are our people. We know them and we know the mechanisms by which we can help

them, the institutions and the pressure points. We can marshal our own worldwide community on their behalf. We hope the shoe makers are doing something for the shoe makers, and we support organizations of broader scope, such as Amnesty International. Meanwhile we do what we can.

Even within and beyond groups there are delicate distinctions. For example, compare our relations with the Russian refusniks and with the dissidents. The dissidents want to change the Soviet Union. The refusniks simply want to leave it. It is with respect to the dissident reformers that the definition of the human rights commitment of the scientific community becomes Talmudic. The American professional societies have decided they cannot reform Soviet society. Thus, there was considerable soul searching when Yuri Orlov was arrested for publicizing violations of the Helsinki Accords. The argument for aiding Orlov, finally, was that the Helsinki Accords recognize science as a source of human benefit. Thus, the question of aiding Orlov was posed in terms of us assisting in the protection of scientists whose activities are supported by the Helsinki Accords. In fact, at least in physics circles, this argument did not prevail until Orlov was actually tried and sentenced. After Orlov's conviction and sentencing, the A.P.S. sent a cable to the Soviet Academy of Sciences stating that it regarded "both the nature of the trial and the severity of the sentence as serious affronts to human dignity and impediments to scientific progress and cooperation." We are now sending physics journals to Orlov in prison which he is not getting (although return receipts come back). We may have done nothing to keep Orlov out of prison, but at least we are trying to help him work as a physicist while he is there.

To the reader, these Kafkaesque distinctions may sound pretentious and trivial when human life hangs in the balance. Things could be worse. The American Association for the Advancement of Science has a Clearinghouse on Science and Human Rights. Thirty-three scientific societies belong to the clearinghouse, but of these, only a handful — the chemists, mathematicians, physicists, psychiatrists, and psychologists — have become actively involved in human rights. It is easy to become discouraged that not enough is being done, but the professional societies of political scientists, sociologists, and medical doctors are still debating about whether human rights is an appropriate professional concern.

The scientific societies that have become active in human rights have done so only because there is a consensus — and some activists — among their membership. When the Soviets sentenced Yuri Orlov and Anatoly Shcharansky last spring, 2,400 American scientists reacted, including 13 Nobel laureates, 113 members of the National Academy of Sciences, 18 past or present directors of major scientific laboratories, and 20 past or present presidents of national scientific organizations. The 2,400 scientists signed pledges to "withhold all personal cooperation with the Soviet Union," to oppose the expansion of exchange programs, to boycott international conferences in the U.S.S.R., and to work against technology transfer and the granting of

The Red Guide (Not by Michelin)

The importance of Western scientists visiting the Moscow seminar has been recognized in "Guidelines for Visitors to the Soviet Union," published in the November, 1976, issue of *Physics Today*. Some excerpts: "The decision to boycott visits as a protest of the treatment of dissident Soviet scientists is a personal one; however, this is a useful action only if it is made known to appropriate persons in the Soviet Union.

"If one does visit the Soviet Union, one should go with the thought of taking constructive actions to help maintain the scientific capability and physical well-being of the suppressed scientists. These actions should include making personal contacts with the scientists and participating in their seminars.

"The expression of one's concern for the suppressed scientists, in conversations with Soviet scientists and officials, should include businesslike discussion of the possible consequences for scientific and technical exchange and an emphasis on the situations of individual scientists.

"If one attends international conferences in the Soviet Union, one should insist on the rights of suppressed scientists to attend on an equal basis." □

"It was
the war in Vietnam that finally
routed 'objectivity.' "

most-favored-nation trade status to the Soviet Union. The action was even more remarkable because it was spontaneous. The organizer, Scientists for Orlov and Shcharansky (S.O.S.), is an informal (and so far, unfunded) group of mostly West Coast scientists, friends of Orlov, who decided to protest his imprisonment and try to help him. Perhaps because the boycott is so clearly a grass-roots effort, the Soviet response has been huge and high-level. Valentin Zorin, one of the top Russian political commentators, inveighed against the boycott in a broadcast beamed at the United States from Moscow. A page-long article was published in *Pravda* and signed by two vice presidents and the chief scientific secretary of the Soviet Academy of Sciences. And we have learned that members of the Soviet Academy have discussed the consequences of the boycott for Soviet science. The Russians know that they benefit from the influx of ideas from American science, and they are worried. But are they worried enough to release Yuri Orlov from prison?

Activism is spreading among Western scientists. The Dutch have always been very active in human rights and lately the French scientific community has grown more militant. In Germany, at a nuclear physics symposium in May, and in spite of the protestations of the Soviet delegation, 50 scientists signed a statement asking for Orlov's release from prison.

While unofficial groups in Britain, notably those associated with physicist and human rights author John Ziman, have an outstanding record on human rights, some of the United Kingdom scientific establishment has dug in its heels. In his 1977 presidential address to the British Association for the Advancement of Science, Sir Andrew Huxley argued that "The persecutions of the present day are not directed against scientific doctrines or against scientific enquiry as such; they are directed against individual citizens who have had the courage to speak up against oppressive features of the regimes under which they live . . . The appropriate reaction therefore comes from us not as scientists, but as citizens . . . If a scientific body publicly takes a step whose justification is political and not scientific, it will lose the right to claim that it is acting purely in the defense of science."

To many of us in the United States, the separation between "science" and "scientist" seems less clear-cut than it does to Sir Andrew Huxley. We see the growing human rights involvement of the American scientific community as an integral part of its broadening definition of what constitutes "science." The continuing evolution of the commitment of American scientists to human rights does involve a conflict. On one hand, there is a yearning for purity and detachment, but on the other hand, there is a growing recognition that science is as complex and "dirty" as any other human endeavor.

We quote from the address of the outgoing 1977 A.P.S. president, George Pake: "Part of our heritage in the United States is a deep concern for human rights. This concern is a legitimate province for the American Physical Society when physicists or scientists anywhere have their basic human rights abridged, because the fundamental purpose of A.P.S. as a scholarly society is thus inhibited. . . . That purpose is stated in the A.P.S. constitution to be the advancement and diffusion of the knowledge of physics. If the governments of nations interfere on political grounds with the ability of physicists to engage in research or with their freedom to publish or travel in diffusing knowlege of physics, there is interference in achieving our purpose."

We are pleased that a community dedicated to the advancement and diffusion of the knowledge of science finds within the penumbra of its mission the advancement and diffusion of human rights. We are proud to be a part of that community.

Earl Callen is professor of physics at American University and former chairman of its Physics Department. He is a member of the Committee on International Freedom of Scientists of the American Physical Society, a member of the executive board of the Committee of Concerned Scientists, a member of the national board of directors of the American Civil Liberties Union, and a member of the executive board of Helsinki Watch. **Bernard R. Cooper** is professor of physics at West Virginia University in Morgantown, W.V. He is a member of the executive board of the Committee of Concerned Scientists and former chairman of the Committee on International Freedom of Scientists of the American Physical Society. **John Parmentola** is a postdoctoral fellow in physics at M.I.T. and a member of the American Physical Society's Committee on International Freedom of Scientists.

INSIDE FAIRCHILD

CLOSE-UP: SENIOR RESEARCH OPPORTUNITIES

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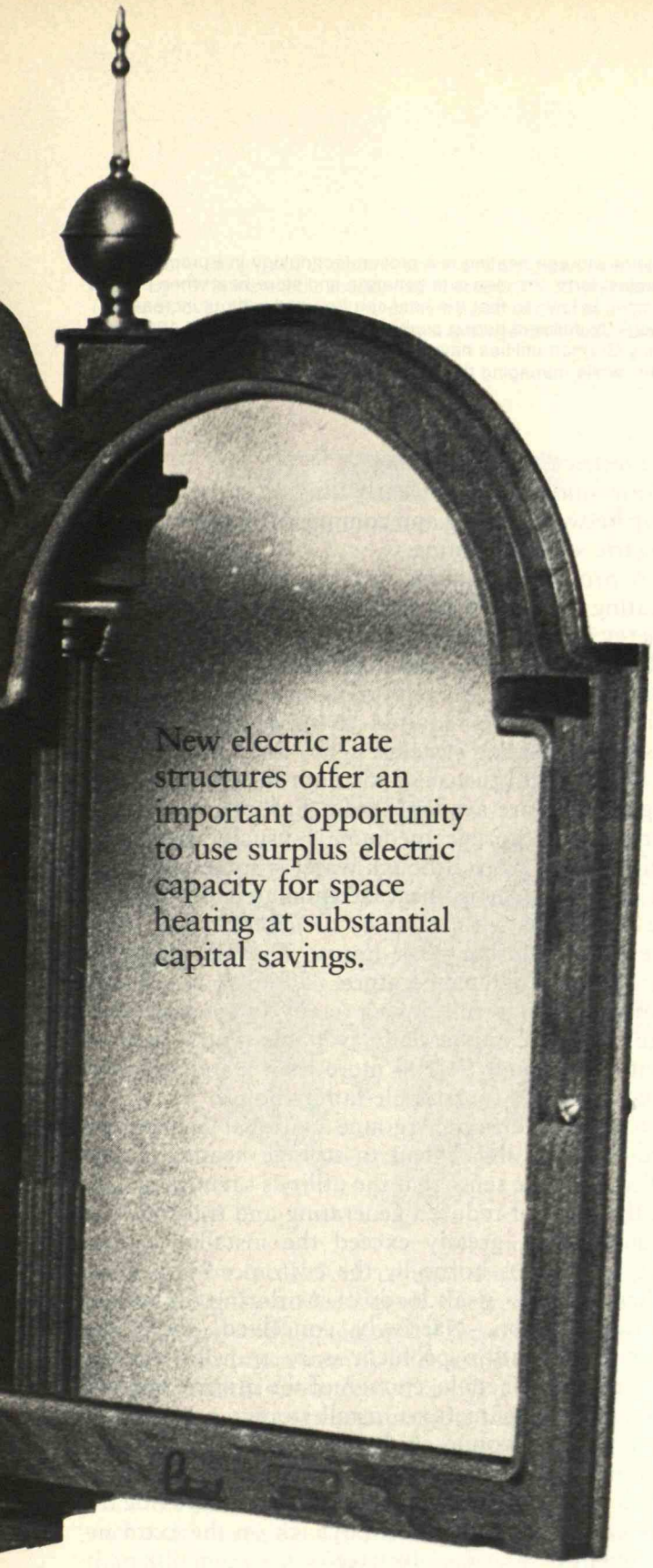
Electric Heat: The Right Price at the Right Time

by J. G. Asbury, R. F. Geise, and R. O. Mueller



New electric rate structures offer an important opportunity to use surplus electric capacity for space heating at substantial capital savings.

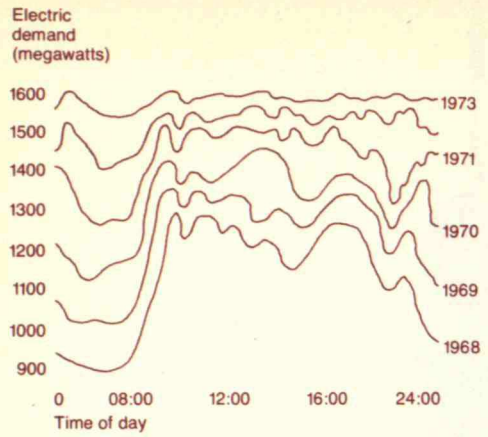
About half of all new houses in the United States are equipped with electric space heating systems. The limited availability of natural gas in many parts of the country, and home-buyer resistance to fuel oil, have been key factors behind the trend toward electricity. Whether this trend continues will depend as much on how efficiently electricity is managed and used as on the price and availability of the competing fuels.

For many conservationists, the use of electricity to heat homes is at best an inelegant practice; one critic likens it to "cutting butter with a chain saw." However, economic efficiency — if not thermodynamic efficiency — can favor the use of electricity. Two important considerations are represented in that statement:

☐ Electricity can be produced from relatively abundant coal and nuclear fuel, replacing domestically scarce (and expensive) oil and natural gas.

☐ At least for some years into the future, home heating can make use of low-cost, off-peak electricity, thus avoiding the high capital costs normally associated with generating and distributing electricity. As we describe below, this can be accomplished either by incorporating a thermal energy storage device in the heating system or by adding a dual-fuel backup capability.

Many readers will be familiar with the thermodynamic argument against electric resistance heating: in terms of the ratio of useful heat delivered to heat content in the utility fuel, resistance heating is very low. But there are many ways to heat with electricity. When heat pumps are used, for example, overall thermodynamic efficiency, counting losses in electric generation and transmission, can be brought up to the level achieved by oil and natural gas furnaces. Several other electric technologies also have superior cost-performance characteristics. They are little used in the United States because this country lacks residential electric rates that accurately reflect the impact of the customer's electric load on the utility supply system. As we shall point out, the commercialization of efficient electric heating systems depends on the design and adoption of such electric rates.



Electric storage heating is a proven technology in Europe; in simplest form, the idea is to generate and store heat when electric demand is low, so that the heat can be used without increasing electricity demand during peak-demand periods. Since 1968, many German utilities have been able to add to their off-peak loads while managing the shape of the peak loads.

Marginal-Cost Pricing

The capacity of any electric system has to be large enough to meet, with an appropriate margin of safety, the maximum demand on the system. The company's costs, both for capital equipment and for operations, are highest during peak-load periods when customer demands are pressing against the utility's capacity to supply power. But most residential electric rates do not take into account the extra cost of peak capacity; they are based on the average cost of all electricity produced.

Economists in this country and Europe have devised marginal cost pricing rules that specify how utilities' capital and fuel costs should be allocated between peak and off-peak periods. Pricing strategies based on these rules are sometimes called "efficient" in the sense that their goal is to maximize the benefits to consumers from the consumption of electricity while simultaneously minimizing the utilities' costs of supply. By setting prices higher during peak-load hours and lower during the off-peak hours, peak-load pricing discourages consumers from using electricity during peak-load periods, thus reducing the demand on utilities for capital-intensive additions to plant and equipment; and it encourages customers to install electric equipment, including heating devices, that selectively use off-peak electricity.

By giving consumers prices which are consistent with utilities' costs, peak-load pricing can lead to more efficient use of a utility's generating, transmission, and distribution facilities. For customers, this pricing system unlocks the benefits of low-cost, off-peak electric heating.

The general issue of marginal cost pricing is beyond the scope of the present article. Clearly, it is broader than the problem of commercializing specific technologies. In this article we shall be content to describe the efficient space heating systems which could be commercialized through the introduction of peak-load pricing.

In the following paragraphs, we examine four generic types of electric and electric-assisted heating systems.

I. Electric Storage Heating

No technology more clearly illustrates the relationship between pricing and commercial feasibility than electric storage heating.

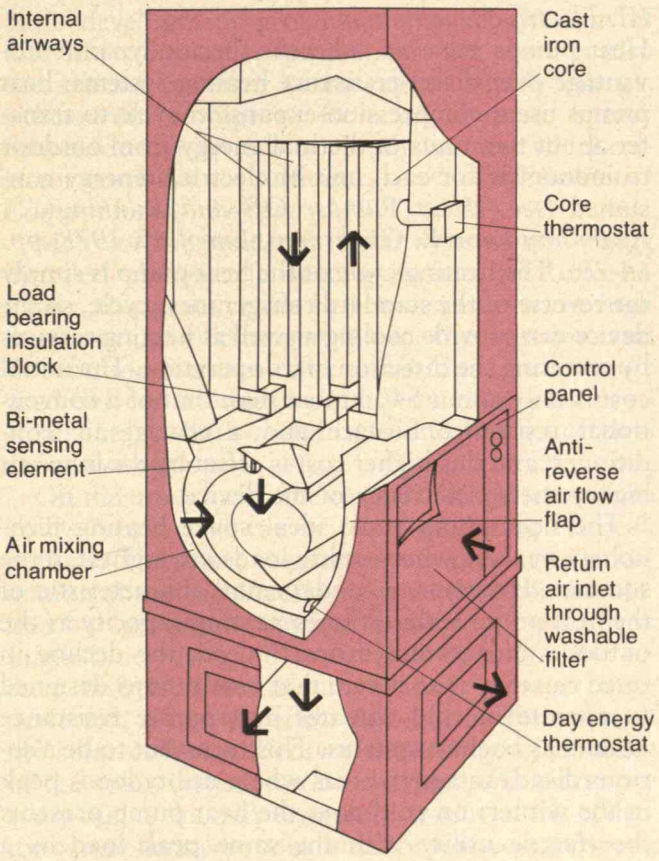
A proven technology in Europe, electric storage heating is a method of storing off-peak electric energy in thermal form for application during peak-load hours. The principal benefit is a reduction in the utility's peak capacity requirements below those which would be required to supply conventional resistance-heating systems.

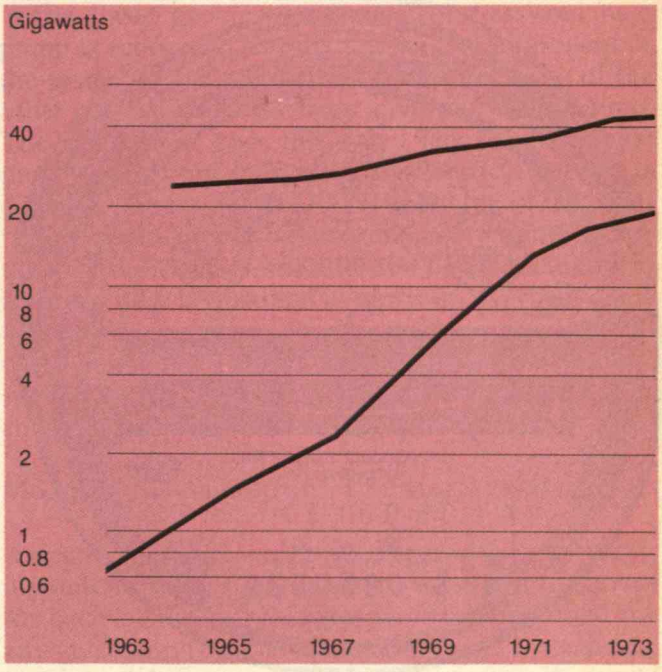
Both central furnace and room-size storage heating systems are available from European manufacturers. The storage medium is usually refractory brick or cast iron, although water is sometimes used in central systems; heat accumulated during off-peak hours is withdrawn by air circulated through the system during peak hours. The advantage of bricks is the high temperature, 750° C, to which they can be heated, resulting in a relatively compact storage volume. Commercially available central furnace units cost about $1,100 more than standard resistance furnaces for a single-family house.

Recent studies at Argonne National Laboratory indicate that investment in storage heating is justified — in the sense that the utility's savings, mostly in the form of reduced generating and transmission requirements, greatly exceed the installation and operating costs borne by the customer — in areas where utilities' peak loads occur during the winter heating season. Narrowly conceived, then, the commercialization problem is to transfer, by the electric rate schedule, enough of the utility's benefits to induce consumers to install storage heating systems. The Argonne studies indicate that, in most winter-peaking service areas, off-peak rate discounts of about 1.2 cents per kilowatt-hour will provide the customer with a five-year payback on the extra investment in a storage furnace.

Storage heating was commercialized in both Britain and Germany through the offer of low off-peak tariffs for separately metered storage heating systems. In return for the low rates, the utilities obtained control over the charging cycle of the storage devices. In Britain, utilities have generally favored time-

In Germany the growth of electric storage heating has been very rapid. By 1973, installed capacity had reached 20,000 megawatts (electric), over 40 per cent of the system peak load for all of West Germany. The chart at the right shows average daily load curves for a typical January day from 1968 to 1973 at the Hamburg Electric Works. In this British-built central storage furnace (diagram at left) the storage medium consists of resistively heated ceramic brick or cast iron.





switching by local clock control. In Germany, they have used pulse-coded signals injected into the supply network and picked up by receivers on the customer's heating system. Under either mode of control, the utility is constrained to operate the charging cycle so as to assure customers the required amounts of thermal energy for space heating. In both Britain and Germany, market penetration was very rapid once off-peak tariff incentives were introduced. In each market region, installed capacity rose from less than 800 megawatts of electricity in 1963 to approximately 20,000 megawatts of electricity by 1973.

To establish the performance required of storage heating systems under U.S. operating conditions, the U.S. Department of Energy is sponsoring field tests of both central and room-sized units in several areas of the country, and the American Electric Power Service Corp., in the largest utility-sponsored project, is evaluating central furnace systems in several of its Midwestern service areas. Central Vermont Public Service Corp. has been accepting storage heating customers on a regular basis for several years.

II. Bivalent Heating System

Another form of off-peak electric heating is one in which an oil- or gas-fired furnace substitutes for the electric heat during periods of high electricity demand. Like electric storage heating, this so-called "bivalent" heating is economical only if some form of peak-load pricing is in effect where it is used: the customer must be rewarded for using off-peak electricity to justify the extra cost of the oil- or gas-fired furnace.

"Off-peak electric systems will provide substantial savings compared with traditional electric systems and, in many cases, with either oil or natural gas."

III. Electric Heat Pumps

Heat pumps have an inherent thermodynamic advantage over direct-resistance heating systems: heat pumps use a compression-expansion cycle to transfer about two units of thermal energy from outdoor to indoor air for each unit of electrical energy consumed (*see "Heat Pumps: Off and Running . . . Again" by Leon R. Glicksman, June/July, 1978, pp. 64-70*). The heating cycle of the heat pump is simply the reverse of the standard refrigeration cycle, so the device can provide cooling as well as heating services by reversing the direction of its operation. The initial cost is only about $400 more than that of a conventional resistance furnace and a central air conditioner, and this higher cost is offset by the inherent higher energy efficiency of the device.

The heat pump is an ideal space heating technology in areas where utility loads are highest in the summer. However, a fundamental characteristic of the heat pump is that it loses heating capacity as the outdoor temperature drops; indeed, the decline in rated capacity is so severe that heat pumps designed to operate in cold climates incorporate resistance heaters as backup systems. This turns out to be a serious disadvantage in areas where utility loads peak in the winter: on cold days the heat pump presents the electric utility with the same peak load as a direct-resistance system.

Several technologies are available to reduce the peaking requirement of the conventional heat pump. One technique is to replace the direct-resistance backup with an electric storage heating furnace, so that the backup energy requirement can be supplied during off-peak hours. Another technique is to substitute an oil- or gas-fired furnace for the direct-resistance backup. Conceptually, systems such as these which eliminate the standard heat pump's tendency to add to peak power requirements without sacrificing its inherent thermodynamic advantage appear to represent nearly ideal heating systems.

IV. Solar Heating Systems

Next to residential water heating, residential space heating is the most promising thermal application of solar energy. As in most forms of solar energy, the

basic development problem is the achievement of low-cost solar collection systems. But there is also the serious problem of having to supply energy, either from storage or from an alternate energy source, during periods of cloudy weather when collector output is not sufficient (*see "Solar Economics Comes Home," February, 1978, p. 28*).

Many of the residential solar systems now being installed use electric heating as backup. Unfortunately, this practice can be very expensive: the high fixed costs of electric generation, transmission, and distribution facilities remain; but these facilities are used only on a "standby" basis to cover periods of solar outage. Both natural gas and fuel oil are less expensive options.

On the other hand, the electric backup energy can be less costly if it can be supplied during off-peak periods. The basic requirement is predictive information about the next day's weather so that insolation outages can be covered in advance by off-peak (night-time) energy. This mode of operation can reduce the overall cost of solar heating; however, once perfected, it has the effect of reducing the value of the solar collector. Because the storage component of the solar system can be charged with electricity every night, the only economic benefit of the collector component is to substitute for low-cost, off-peak electricity.

Another way to combine solar and electric heating is to arrange a solar collector either in tandem or in parallel with a heat pump. In the tandem design, the better of the two configurations, the output of the solar collector is used to warm a storage tank that serves as an input reservoir for the heat pump. According to its advocates, such a solar-assisted heat pump enjoys one important advantage over each of the two simpler space heating systems it might replace:

☐ In comparison with the conventional air-to-air heat pump, efficiency is improved because of the solar warming of the input reservoir.

☐ In comparison with conventional solar systems, cost is reduced because the collector does not deliver energy directly to the house; a lower-cost, lower-temperature collector can be used.

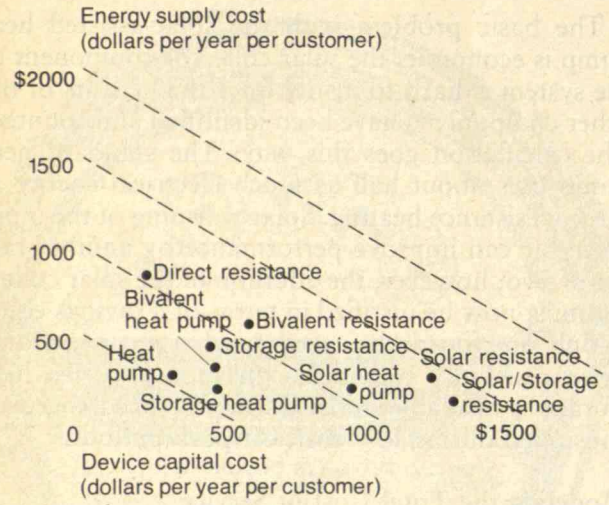
The basic problem with the solar-assisted heat pump is economic: the solar collector component of the system is hard to justify once the benefits of the other components have been identified and counted. The calculation goes this way: The standard heat pump uses about half as much electrical energy as direct-resistance heating. Solar warming of the input reservoir can improve performance by another factor of two; however, the addition of the solar collector must now be justified in terms of a savings equal to only one-fourth the energy used by a conventional direct-resistance system. Furthermore, because heat storage is available, most of the displaced energy is consumed during low-cost, off-peak periods.

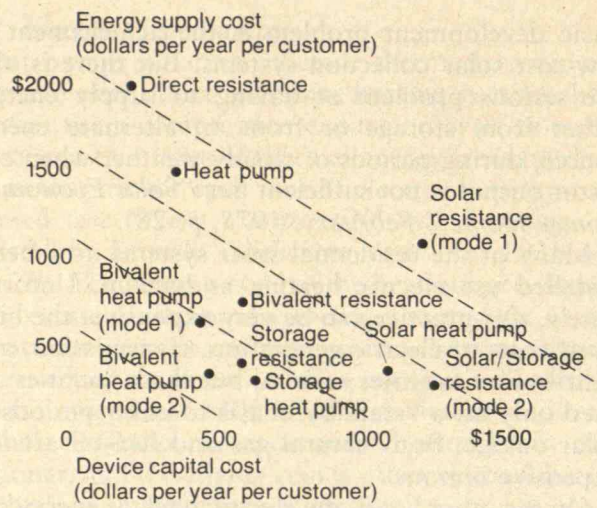
Modeling the Total Cost of Service

If electrical energy were priced at true marginal cost, it would be easy to calculate the total cost of service for each of the technologies we have described for any given application. In the ideal case, it would be the sum of the customer's annual electric bill and the annual mortgage payment on the space heating equipment. However, in the absence of correct pricing (cost) signals from the electric utility, the problem becomes more difficult, requiring a detailed utility system cost analysis.

In a study sponsored by the Division of Energy Storage Systems, U.S. Department of Energy, we applied the Argonne cost allocation model SIMSTOR to estimate utility supply costs in different parts of the country. The SIMSTOR computer model uses the performance characteristics of specific heating systems and hourly weather data to calculate space heating loads over a full annual cycle. It then computes the cost to the utility of expanding its generating, transmission, and distribution systems to meet these load profiles and the fuel costs to operate its generating plants. Although its data requirements are rather demanding, SIMSTOR can be applied to any electric supply system.

Estimating the contribution of the customer's space heating equipment to the total cost of service is easier than estimating utility costs. Except for solar technologies, the costs to the customer of pur-





The two components of the total cost of electric space heating are displayed on this page for a winter-peaking service area (left) and a summer-peaking utility (right). The vertical axis, representing the cost of electric supply to the space heating technology, can be conceived as the electric utility's annual fuel bill plus the annual mortgage payment on the plant capacity needed to meet the electric load. The horizontal axis represents the customer's annual mortgage payment on the space heating equipment. The dashed lines indicate points having constant total cost.

chasing and maintaining space heating equipment can be reliably estimated from data supplied by equipment manufacturers and building contractors, and these data have been used in our studies. Solar system costs are less certain; our estimates represent somewhat optimistic projections of near-term installed system costs: $15 per square foot of collector area, $1 per gallon of storage capacity, and an incremental cost of $1,000 for plumbing and controls. For the solar-assisted heat pump system, where lower-performance collectors are acceptable, collector costs were assumed to be $10 per square foot.

Two different operating strategies for solar/electric-resistance heating systems were studied. Under the first strategy, which corresponds to the conventional mode of operation, the electric backup furnace was switched on as required to augment the heat flow from the solar collector or the storage reservoir. Under the second mode, auxiliary energy requirements as calculated in advance were put into the storage reservoir during the previous night-time period.

Each of the heating technologies was sized to meet the heating requirements of a well-insulated, 1,500-square-foot single-family house. In the case of solar systems, the collector was sized so that solar energy met 50 per cent of the space heating load on an annual basis; electricity supplied the rest.

Though cost analyses of the different heating technologies were performed for a number of different regions of the country, we present here results for two areas which best illustrate the important factors affecting the overall cost of service. One of these areas is in the Northeast, supplied by an electric utility whose peak load occurs during the winter heating season; the other, in the middle-Atlantic region, is served by a summer-peaking utility.

The figures above show that storage and bivalent systems are the most efficient technologies in the winter-peaking service area while the conventional heat pump is the lowest-cost technology in the area supplied by the summer-peaking utility. Solar heating systems, even with the low-collector-cost assumptions of this study, exhibit relatively high total costs.

Market Penetration: When the Load Becomes Level

Energy supply costs were calculated in our study by adding a relatively small incremental load (1,000 customers) to the present utility load curve and determining the capital and fuel costs needed to meet the new load. Strictly defined, these costs represent long-run marginal costs only if the utility's load curve does not change shape over time.

However, this condition will not hold indefinitely. This is because the basic problem is that, given an available load-leveling technology and the incentive of lower off-peak rates, consumers will shift their energy use from peak to off-peak periods. As this trend continues, the daily load curve will become level, and users will be contributing to the demand for additional utility capacity during both the daytime and night-time periods. This means that in the long run energy supply costs for the off-peak heating technologies will be somewhat greater than indicated in our analyses while the costs for direct systems will be somewhat less.

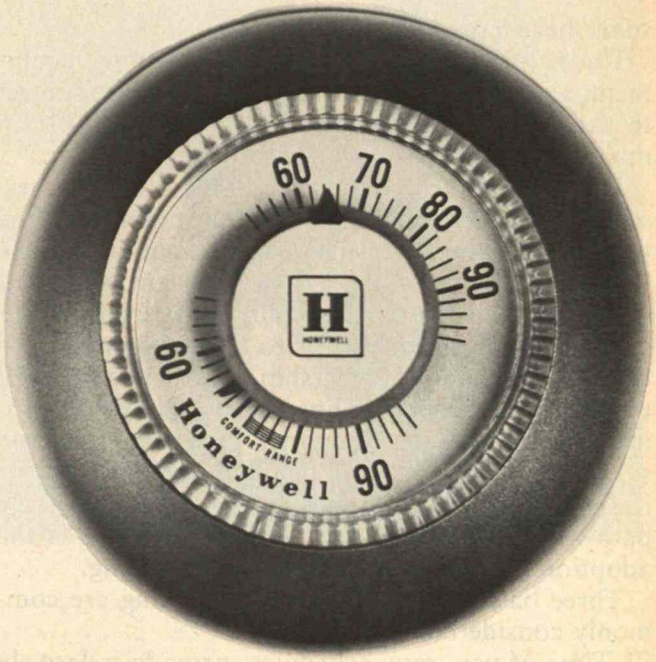
The fact is, however, that balanced long-run load curves will not be achieved for many years; and until then off-peak electric systems, as indicated in the figures, will provide substantial savings compared with traditional electric systems and, in many cases, with either oil or natural gas.

We conclude that, depending on the service area, either the bivalent heat pump by itself or a system of conventional and storage heat pumps represents the optimal load-leveling and cost-minimizing electric heating sytem. In fact, such heat pump systems with off-peak pricing will even today provide space heating in many parts of the country for less total cost than either fuel oil or natural gas furnace systems.

Commercialization: How to Go from Here to There

The economic barrier to the installation of efficient heating technologies is the present-day electric rate schedule. There are essentially two ways of overcoming this problem:

- ☐ The adoption of efficient electric rates;
- ☐ The taking over by utilities of the ownership of



Peak-load pricing discourages consumers from using electricity during peak-load periods, thus reducing the need for utilities to invest in additional plants and equipment.

space-heating equipment.

Under the second method, space-heating equipment, as part of the utility system, would be subject to the same least-cost criterion that utilities use in making other investment decisions.

Although there are precedents for utility ownership of on-site technology — the most familiar is the telephone — the experience of electric utilities in the United States has not favored utility ownership of space heating equipment. Utility ownership raises serious issues about access to the equipment and transfer of building ownership, and it would bring the utility the responsibility (and nuisance) of owning and maintaining thousands of widely dispersed systems on which the well-being of customers is critically dependent. We conclude that the more likely path to more efficient space-heating systems is the adoption of some form of peak-load pricing.

Three basic forms of peak-load pricing are commonly considered:

☐ Time-of-use rate schedules provide relatively high rates for consumption during peak periods and much lower rates during off-peak periods. Although they are rooted in the principles of marginal cost pricing, in practice time-of-use schedules often present serious problems. The typical time-of-use tariff involves a discrete number of pricing periods — two or three daily periods and at most three seasonal periods; in contrast, the utility has available a continuum of capacities and performance characteristics. As a result, in the case of storage heating, for example, customers will find it advantageous to install undersized storage devices, making up the shortfall on "worst-case" weather days with direct-resistance heating. Such customers will enjoy most of the benefits of off-peak heating without reducing the electric utility's peak capacity requirement.

☐ Demand charges represent a monthly supplemental charge, in dollars per kilowatt, on energy used in periods of peak demand. These charges involve relatively inexpensive metering and are easy to understand. They provide a strong disincentive to the use of peak-period energy and discourage the installation of undersized storage or other load-leveling equipment. Unfortunately, demand charges have not proven to be popular with residential customers. Particularly onerous, it seems, is the high cost of a "mistake" due to the consumer's carelessness in scheduling appliance loads. The $30 clothes-dryer load is the apocryphal example.

☐ Load-management contract rates are device-specific rates which can be tailored to modify the effects of one particular device on the utility supply network. The utility may impose standards or limits on energy-consuming equipment, and/or choose to control the operating cycle through clock, radio, or ripple techniques. The basic concept is to provide the customer with lower-cost service in return for his giving the utility control over the type, capacity, and operation of one or more energy-consuming devices.

Each of these forms of peak-load pricing is superior to the traditional flat rate currently in force in most U.S. service areas; peak-load rates, combined with programs to inform customers of their availability, represent *the* instrument for more efficient space heating in the United States. Of the three forms of peak-load pricing, the load management rate offers the greatest potential for minimizing the overall cost of providing electric space-heating services.

Suggested Readings

Asbury, J.G., R.F. Giese, R.O. Mueller, and S.H. Nelson, "Commercial Feasibility of Thermal Storage in Buildings for Utility Load Leveling," *Proceedings of the American Power Conference*, 1977.

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Koger, R.K., "Regulatory Constraints on Solar Energy and Thermal Storage Installations," *Public Utilities Fortnightly*, January 19, 1978.

The authors are with the Energy and Environmental Systems Division, Argonne National Laboratory. **Joseph G. Asbury** is director of the Special Projects Group and manager of systems evaluation, Argonne Chemical and Electrical Systems Program; he is currently directing a number of economic and system studies of energy conservation and supply technologies. Dr. Asbury received his Ph.D. in physics from Purdue University in 1964. **Robert Giese** is a system analyst specializing in the development of computer simulation and cost allocation models for energy supply technologies; his Ph.D. (1974) is from Stanford University. **Ronald Mueller** (Ph.D. 1972, New York University) is a physicist working on load management, the economics of reliability, and the interface of solar and conventional technologies.

UN MOMENT DE MARTELL

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DINNER IS OVER, BUT THE NIGHT IS STILL YOUNG.

WHAT BETTER TIME TO EXPERIENCE THE WORLD'S FINEST COGNAC—MARTELL.

AFTER ALL, MARTELL COGNAC HAS HELPED MAKE EVENINGS MEMORABLE SINCE 1715.

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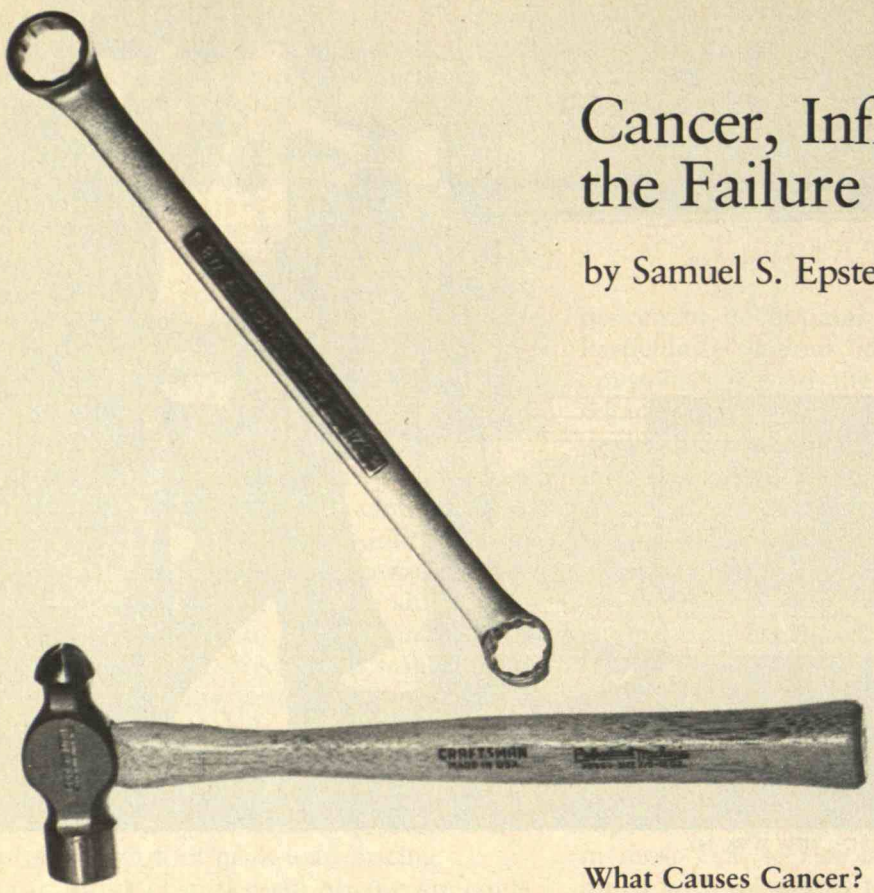


Cancer, Inflation, and the Failure to Regulate

by Samuel S. Epstein

Over the past few decades, there has been a steady accumulation of scientific data on occupational and environmental carcinogens. There has also been a parallel increase in our ability to test for carcinogenic effects of chemicals in animals and to recognize such effects in humans. Not only is the level of this information generally adequate, but there are ample laws — in spite of their occasional inconsistencies and ambiguities — to translate such information into regulatory action. Yet this has rarely been done.

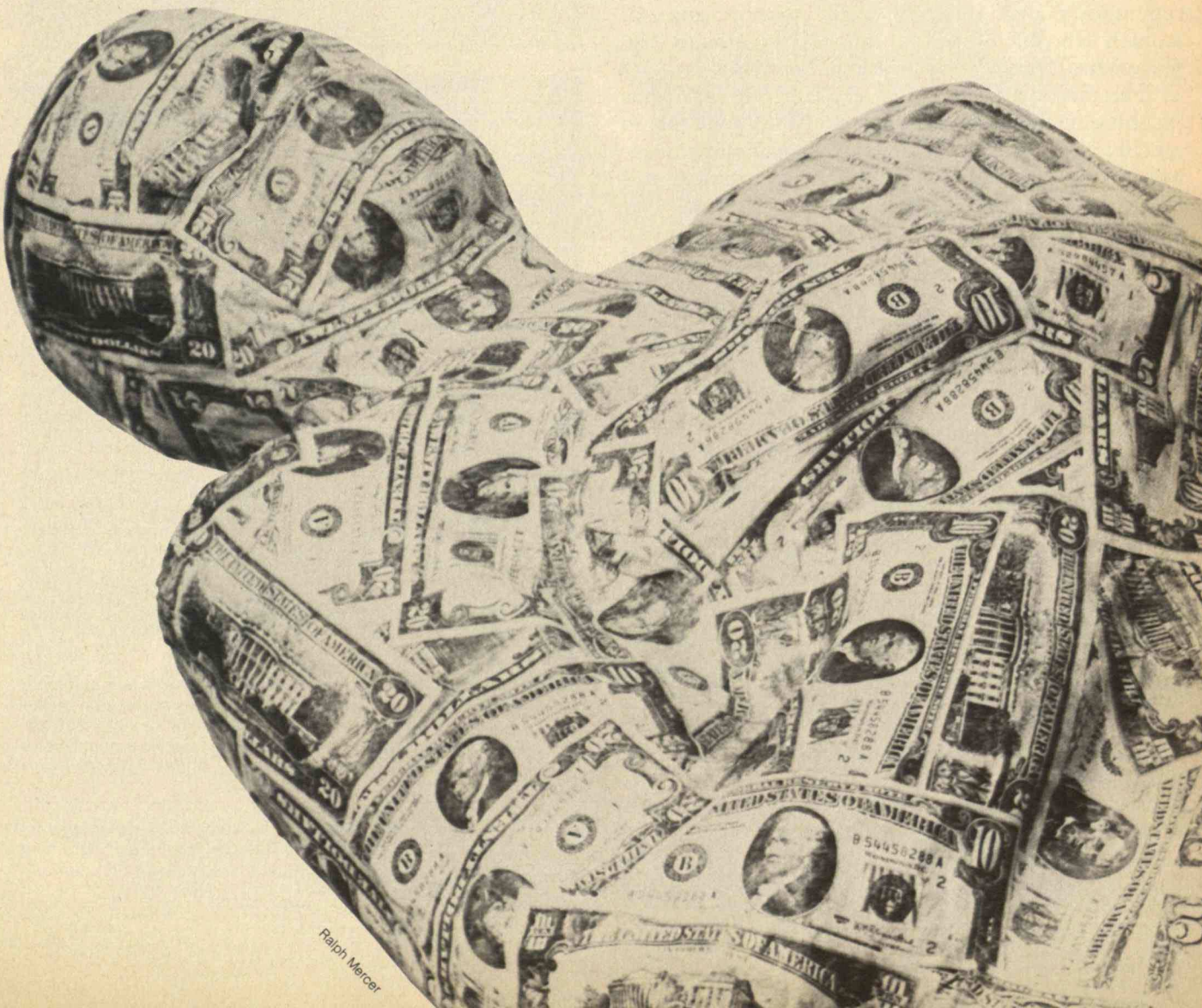
The problem is thus not one of inadequate information or limited authority, but rather one that derives from economic and political constraints. The combination of powerful and well-focused pressures from industry, together with an indifferent scientific community, public confusion, and a relatively weak public-interest movement, has created a major political imbalance. This has been further exacerbated by the "anti-inflation" policies of the Carter administration which fail to recognize that the true costs of *failure* to regulate are excessive and inflationary.

What Causes Cancer?

Cancer strikes one in every four Americans and kills one in five. It is not a disease of degeneration or aging. There is little or no evidence that viruses play a significant role. Similarly, migration studies have shown that genetic factors are unlikely to be important determinants of human susceptibility. Cancer affects all ages and is largely an expression of past exposures to carcinogens in air, water, food, drugs, consumer products, and the workplace.

Our overall ability to treat and cure cancer — once it has been manifested — has not materially improved over the past few decades. With the exception of prostate cancer and certain relatively rare cancers such as Hodgkin's disease and acute leukemia in children, the odds of a cure for the major cancer killers — those of the lung, breast, and colon, for example, — are not much better now than they were 20 years ago (*see table, p. 44*). This is true despite the billions of research dollars spent on a cure for cancer, despite the high priorities for cancer research created by the 1971 National Cancer Act (which have been and continue to be directed toward curing rather than preventing cancer), and despite the optimistic assurances of the American Cancer Society (even though based on the same National Cancer Institute (N.C.I.) data such as in the table).

If industrial chemicals remain underregulated, they will yield costs — quite apart from suffering and loss of life — that far outweigh the immediate, supposedly inflationary costs of control.



Ralph Mercer

Cancer is now the only major fatal disease whose incidence is on the rise. Standardized cancer death rates (i.e., adjusted for age and based on the total U.S. population) show an overall and progressive increase of about 11 per cent from 1933 to 1970. This increase has been even more striking over the last decade (*see table, p. 48*), and cannot be accounted for by smoking or increased longevity. At today's death rates, the probability of a person born today getting cancer by the age of 85 is 27 per cent (in contrast to about 20 per cent for a person born in 1950).

In addition to the documented increase in overall cancer death rates in this century, evidence for the environmental causes of the disease is provided by a constellation of other scientific findings:

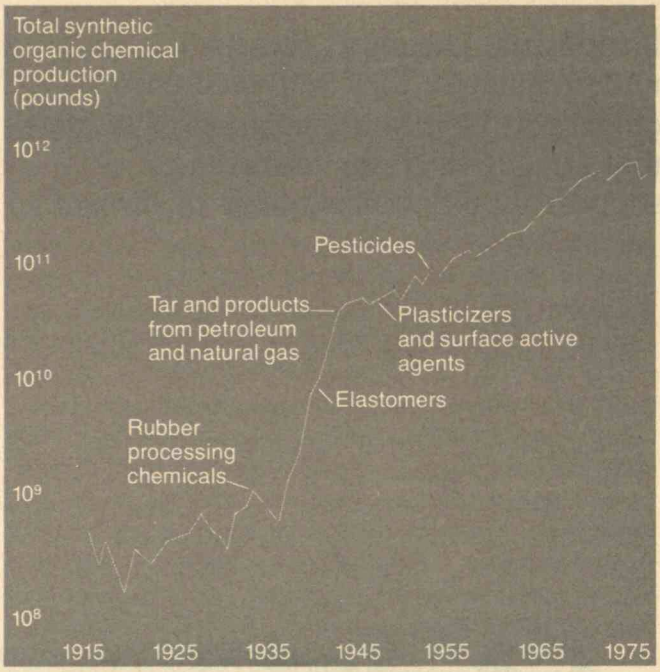
☐ The striking increase in cancer death rates for certain "high-risk" population sub-groups: such as workers in asbestos or petrochemical industries, premenopausal women who have been subjected to repeated mammography, and postmenopausal women who have been administered estrogen "replacement therapy" for prolonged periods.

☐ The major international geographical variations (in some instances by as much as 2,000 per cent) in specific organ cancer rates which have largely disappeared over the course of one or two generations following population migration from high to low cancer areas.

☐ The clustering of excess overall cancer rates and organ-specific cancer rates in men and women living in heavily industrialized U.S. counties (*see table, p. 47*), particularly those with a high concentration of petrochemical and certain mining and processing industries.

☐ The experimental demonstration of the carcinogenic effects of a wide range of chemicals, particularly synthetic organics.

Since the advent of the petrochemical era in the 1930s, a vast array of new synthetic organic chemicals has been introduced into commerce — and into the environment — generally without prior testing for carcinogenic and other chronic toxic effects. By 1976, total U.S. production of synthetic organic chemicals had reached 300 billion pounds per year, up from about 1 billion pounds in 1940 (*see figure above*). And about 700 new chemicals are presently being introduced into commerce each year. But it must be appreciated that the "cancer problem" thus created can readily be solved. The property of carcinogenicity is in fact relatively rare, and can be practically and economically detected by animal tests that are highly predictive of human effects. Of the



5-year relative survival rates for cancer in whites (per cent)

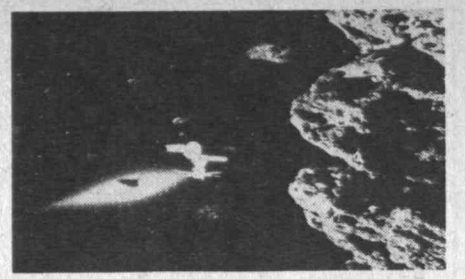
Type of cancer	Sex	1960–1963	1970–1973
Lung	M	7	9
	F	11	14
Breast	F	63	68
Cervix	F	58	64
Uterus	F	73	81
Prostate	M	50	63
Colon	M	42	47
	F	44	50
Stomach	M	10	12
	F	13	14
Hodgkin's disease	M	34	66
	F	48	69
Childhood leukemia	M	4	26
	F	4	33

Above:
Production of synthetic organic chemicals in the U.S. has grown dramatically during this century. In 1940, for example, one billion pounds were produced; by 1976, total production reached 300 billion pounds. (Arrows indicate when usage of specific product types became officially "significant.") (*Source: U.S. International Trade Commission*)

Below:
These data — obtained in 1979 from the National Cancer Institute's Surveillance Epidemiology and End Results (S.E.E.R.) Program — suggest that our overall ability to cure cancer has not materially improved over the past decade.

MIT

This page: Homecoming (see page A24) Photo: James J. Snyder, courtesy *Technique*



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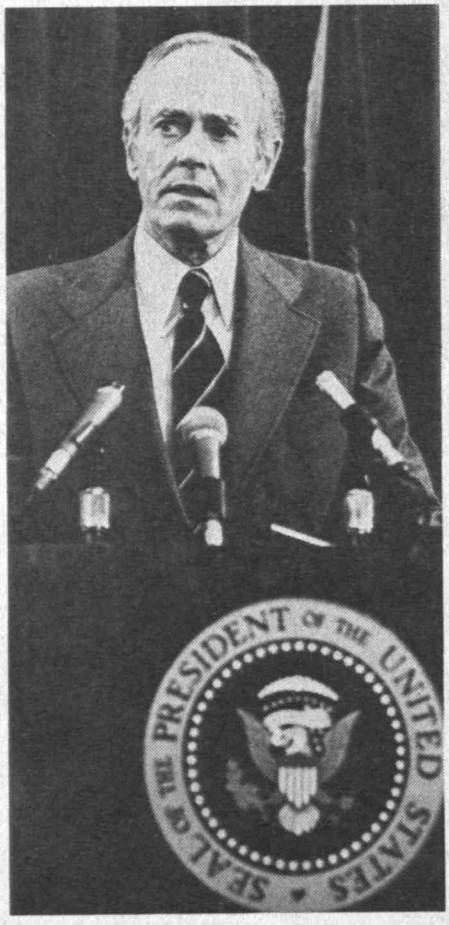


METEOR™

How Project Icarus Went to Hollywood

by Robert M. Byers

Where else but M.I.T. could you go to college and have a term paper wind up as a $17 million Hollywood movie?

It took a decade, but that has happened for 21 alumni who, as seniors and graduate students in the spring semester of 1967, took the course in Advanced Space Systems Engineering (16.74) in the Department of Aeronautics and Astronautics.

The subject, begun in the early 1960s and usually taught by a visiting professor from industry or government, challenges the class to work as a team on some large-scale engineering task. The idea is to give students a foretaste of working cooperatively in a group effort.

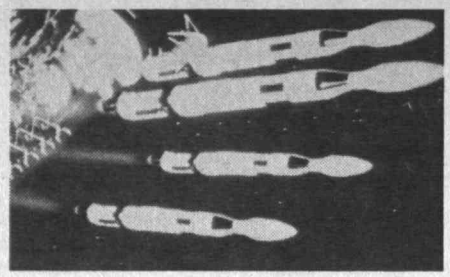
Classes typically develop "paper" plans for such undertakings as communications satellite systems, space colonies, etc. In the 1960s, this approach to engineering education was sufficiently novel that the M.I.T. News Office sought each spring to publicize the class results and the M.I.T. Press, as a service to engineering educators elsewhere, published the final class reports as paper-bound books.

When Paul E. Sandorff, '39, then visiting professor on leave from Lockheed Missiles & Space Co., Inc., told the class members in the spring of 1967 to make believe the asteroid Icarus would collide with Earth a year hence and to develop a plan to avert the catastrophe, no one guessed that Hollywood might be listening.

American International Pictures' Meteor, *directed by Ronald Neame, stars Sean Connery, Natalie Wood, Karl Malden, Brian Keith, Joseph Campanella, Trevor Howard, Richard Dysart, and Henry Fonda as the President of the United States. (The* New York Times *suggests that since Mr. Fonda has played that role so often he should consider running for the office.) Photos: American International Pictures*

Mythical Problem, Real Solution

The assignment had only remote connections with reality. The 2,000 or so known asteroids orbit the sun between Mars and Jupiter at a distance roughly where Bode's Law says a planet should be and are believed to be the makings of a planet that failed to coalesce. Scores of them, known as the Apollo asteroids, follow elliptical orbits that periodically bring them close to Earth;



one of these is Icarus, which passes within 4 million miles of our planet every 19 years, the last time being June 19, 1968.

Given more than a year's lead time, Professor Sandorff's students were to imagine that Icarus, more than a mile in diameter, suddenly was found to be on a collision course with Earth and would impact at 12:26 P.M. (G.M.T.) on that date in mid-Atlantic. It would splash out a thousand cubic miles of sea water, form a crater 15 miles across in the ocean floor, and release the energy equivalent of 500 billion tons of TNT. Tidal waves 100 feet high would wipe out cities on both sides of the Atlantic, and earthquakes 100 times worse than any ever recorded would be felt world wide.

While the problem was mythical, the solution the class developed was real enough. Sparing no expense, they provided all preliminary engineering design and analysis to launch six 100-megaton hydrogen bombs into the path of the asteroid atop Saturn rockets then being readied to carry men to the moon.

When the students presented their plan in May, 1967, newspapers carried it for just what it was — a class project ("Can Tech Men Stop Icarus?" asked *The Boston Globe,* "Avoiding an Asteroid," said *Time* magazine). But then came the M.I.T. Press book, *Project ICARUS: M.I.T. Student Systems Project,* early in 1968. When they saw it, the book quickly enough suggested an adventure-drama film to independent movie producers Theodore Parvin and Arnold Orgolini in Hollywood. And several years later, when they succeeded in putting together the financing, the public had developed an appetite for "disaster" movies, films built around natural or man-made disasters, and *Meteor* went into production. Directed by Ronald Neame (who directed *Poseidon Adventure*) and released last fall by American International Pictures, Inc., the new movie stars Sean Connery, Natalie Wood, Karl Malden, Brian Keith, Martin Landau, and Henry Fonda as the president of the United States (which later was to cause the *New York Times* to suggest that since Mr. Fonda has played that role so often he should consider running for the office).

Brian Keith (above) stars as the leading Soviet space scientist called upon to aid his American counterparts in preventing a five-mile-wide meteor from colliding with earth. Nuclear missiles are launched from an orbiting satellite (this page top right); skiers are trapped beneath the snow when a fragment of a meteor strikes the Alps, causing an avalanche (below).

Opposite page: Hong Kong residents flee a tidal wave, the result of a meteor fragment crashing nearby in the ocean (top); Henry Fonda and Karl Malden ponder imminent catastrophe. Photos: American International Pictures

Institute permission for the movie was not required or sought since the student study only suggested the film. For example, the threat posed in the movie is not exactly the same as the threat posed to the students, and the solution employed in the screenplay differs considerably from what the students had in mind. Nor does the Institute receive remuneration for the movie in any way. Simultaneously with the opening of the film, the M.I.T. Press republished the original student report, and copies were provided to some 50 television and newspaper movie reporters who were at Flagstaff, Ariz. (picked because of its proximity to Barringer's Crater where a meteor actually once landed in the U.S.) for a world press premiere in mid-October. In addition, an Institute representative was on hand to remind reporters that, despite a chilling printed statement that concludes the movie, the 1967 study was, after all, a class project and not the work of senior scientists seriously worried at the time that the world was threatened by Icarus.

The movie is set at some future time when the U.S. and the U.S.S.R. have orbiting doomsday weapons, and the plot revolves around combining and re-aiming those devices to intercept and destroy an incoming meteor five miles across. Four smaller splinters in advance of the larger body do strike Earth and wreak havoc, wiping out much of Siberia, a portion of the Swiss Alps, all of Hong Kong (lost to a 600-foot tidal wave) and — last of all — the west side of New York City. Mr. Connery and Mr. Malden are American space

scientists in charge of U.S. participation in the joint effort while Miss Wood and Mr. Keith are their Soviet counterparts. Mr. Connery is known to be a professor but his academic affiliation is generally vague. If you listen carefully, however, you will discover indirectly from one line of the dialogue that he is on leave from M.I.T. for the emergency.

"The Definitive Disaster Movie"?

Sophisticates who find joy in demeaning popular entertainment forms will likely fault the movie for technical "errors." But then, war movies, in the interest of dramatic effect, seldom depict real war. To cite one apparent *Meteor* deviation from reality, the orbiting weapons appear to be conventional ground-launched intercontinental ballistic missiles mounted in giant launching racks; and you might ask why, if already in orbit and pointing downward, they would require the same large booster rocket ICBMs employ to escape gravity in the first place? The answer given is that moviegoers would not recognize typical orbiting weapons as missiles, and the movie's special effects — which may win an Oscar nomination — depend on salvos of missiles streaking through space to save the world. (You may find yourself, perhaps for the first time, rooting for ICBMs and thinking of them, if you are given to anthropomorphism, as the guys in white hats — except the Soviet nose cones are painted characteristic red.)

Although the first two salvos miss, the third — and last — connects, and the menacing meteor is destroyed (evaporated, in fact) as the movie concludes with the starkly printed legend: "In 1968, at the Massachusetts Institute of Technology, a plan was designed to deal with the possibility of a giant meteor on a collision course with Earth. This plan is named Project Icarus."

Well, yes, but . . .

Publicity issued by the studio to promote the movie made several references to the 1967 M.I.T. project (the year given in the concluding legend apparently confuses the date of publication with the date of the work). In addition, a classroom study guide on solar system phenomena prepared under studio direction and sent out to 2,000 schools nationwide to further promote the movie contains extensive material describing the student project and the educational reasons for it.

Critical reviews have been mixed. Gene Shalit of NBC's *Today* praised it. Vernon Scott of United Press International called it the "definitive disaster movie" while the *New York Times'* Janet Maslin termed it "standard disaster fare." The *Boston Globe's* Bruce McCabe would only say it "isn't bad" and *Time* magazine panned it heavily.

Arthur S. Hsu '82, reporting the movie for *The Tech,* found it "a good disaster thriller" despite technical flaws and had the good sense to call Louis A. Kleiman, '65, who edited the class report for original publication and who now is an aerospace engineer in the Washington, D.C., area. Mr. Hsu found Mr. Kleiman "delighted" that the long-ago class project had been memorialized by Hollywood.

Robert M. Byers, Director of the M.I.T. News Office, has been busily engaged in clarifying the sources (and non-sources) of Meteor *ever since the film went into production.*

Students were to imagine that Icarus, more than a mile in diameter, suddenly was found to be on a collision course with Earth and would impact at 12:26 P.M. (G.M.T.) on that date in mid-Atlantic. It would splash out a thousand cubic miles of sea water, form a crater 15 miles across in the ocean floor, and release the energy equivalent of 500 billion tons of TNT. Tidal waves 100 feet high would wipe out cities on both sides of the Atlantic, and earthquakes 100 times worse than any ever recorded would be felt world wide.

Leo Small, '81, works at Northrop Precision Products Division as part of the Engineering Internship Program. "I've learned how a production line works and seen how an operation is put together," says Mr. Small of his work experience. "I've learned a lot about myself, what kinds of projects I like and am good at, and what's important to me in a work environment. I know myself better and have a much better idea of what I'll look for in a job and career," he adds. Photo: Northrop News

Engineering Internship Program: Five Years Yield Two Degrees and Work Experience

The idea came out of an M.I.T. self-appraisal study in 1975. The VI-A program in electrical engineering and computer science was a great success; why not allow the whole School of Engineering to participate in such a program?

The engineering internship program was the result. Directed by John R. Martuccelli, '53, it was modeled after the VI-A program and runs in parallel, including students from civil engineering, mechanical engineering, materials science and engineering, electrical engineering and computer science, aeronautics and astronautics, ocean engineering and nuclear engineering.

The program is a five-year combined bachelor's and master's degree which includes work experience. Students do a master's thesis at a company on a company project, in absentia from M.I.T. But there is a constant structured interaction with an M.I.T. professor to insure M.I.T standards, explains Mr. Martuccelli.

Student participators in the program enter at the end of their sopho-

more year. A student will work at a chosen company in the summer following the sophomore year, come back to M.I.T. for the junior year, and go out to the same company the next summer, to accumulate two summers of work experience.

At the beginning of their senior years they apply to the Graduate School (there is no guarantee they will get accepted). Those that are admitted spend their senior years at M.I.T. and then go to their companies for the summer and the first term of their graduate years. Then they spend seven to eight months working on projects at their companies. Part of what they do in this time are their theses. The result: in five years, they get a combined masters and bachelors degrees.

The main benefit to the company is the opportunity to interact with M.I.T. students (and faculty) and the possibility of hiring students upon graduation. And, in a real sense, they are helping and contributing to the growth of the profession. The faculty learns of industry problems and feeds that back into the classroom.

Matching the Company to the Student

How does a student find the appropriate company that fits with this career objective? It is a meticulous process. In the spring of each year, students are briefed on the interests of particular companies by company representatives who give an hour-long talk. Based on that and the input of students who previously participated at that company, students decide which companies command their interest. Experienced-student-to-new-student is the best flow of information, explains Mr. Martuccelli.

Then students and company representatives hold one-half hour one-on-one interviews. Next, each company lets the internship office know how many positions are available and its choice of participants.

By now it is early April. Mr. Martuccelli sits down with students and tells them their options. It is very important to find a company that will provide the student with an experience consistent with his or her career goals, so that the student can look forward to a series of work experiences leading to a challenging and exciting thesis topic, he explains.

A Range of Disciplines and Industries

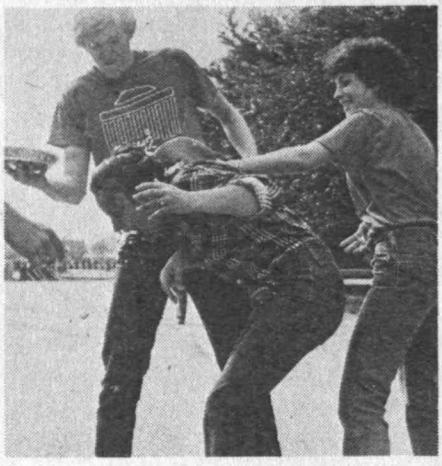
We want the kind of mix of industries represented in the internship program that a student sees when he or she goes out in the work world," says Mr. Martuccelli. "We've been pretty successful since our beginning two years ago." (The first year, they placed 32 students in 12 participating companies. Last summer, 43 students were placed in 24 companies. Next summer Mr. Martuccelli hopes to place 55-60 sophomores.) "Ultimately, we envision 250 students in the internship program and 35-40 companies," says Mr. Martuccelli.

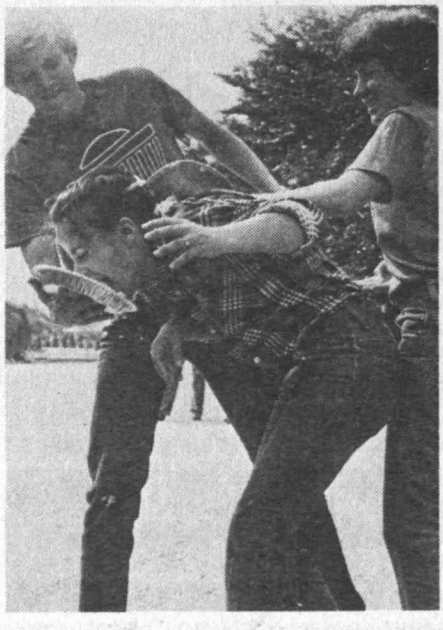
There is a company fee paid to M.I.T. This money defrays partially the cost of running the internship office and pays for faculty support and travel to visit students at the companies.

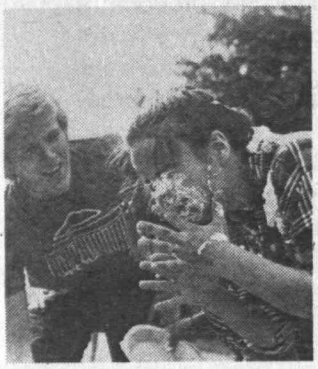
Students receive a salary ($200-$250 a week for to-be juniors) and the company also pays for their travel costs.

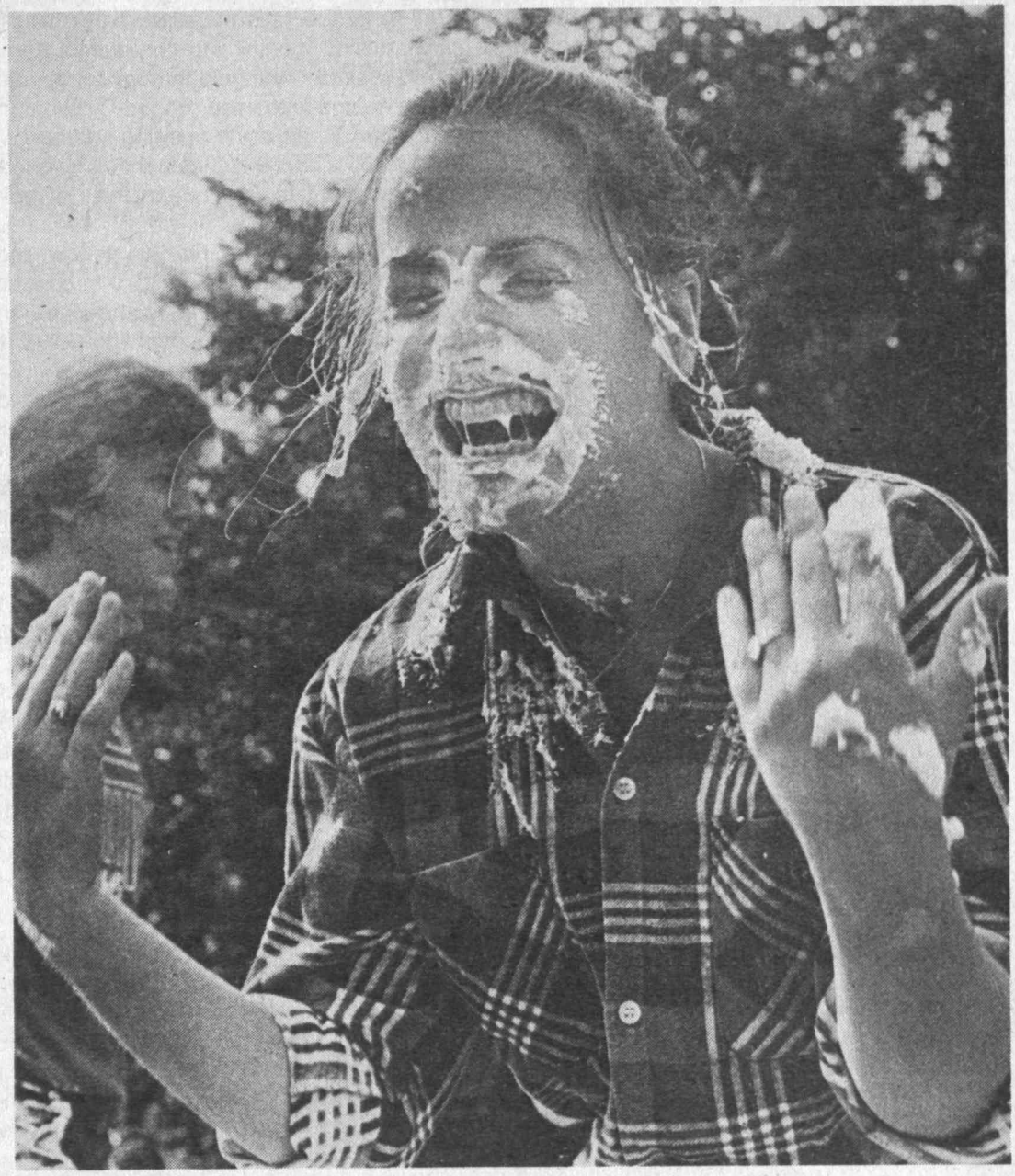
The main benefit to the companies is the opportunity to interact with M.I.T. students (and faculty) and the possibility of hiring students upon graduation. And, in a real sense, they are helping and contributing to the growth of the profession, explains Mr. Martuccelli. The faculty learns of industry problems — and feeds that back into the classroom.

Mr. Martuccelli points out that the M.I.T. student is a good worker, even at the sophomore level. Often by the end of the first work experience many students are seen by companies as equivalent to an entry level engineer. So whether or not the student is hired in three years, the company can use his or her talents productively now. — *M.L.*









Catching her coming and going. Pie-throwing was an announced event for Class Day 1979 on September 29, but Marilee Lyle, '83, clearly got more than her share. Though class spirit through rivalry was the announced purpose, the good vibes apparent in these pictures prevailed. (Photos: Mark H. Sloan, '81, Courtesy of Technique)

Dr. Robert C. Seamans, Jr., Dean of Engineering at M.I.T., spoke to seminar attendants: "We must apply scientific methods to improve productivity, to conserve energy, to develop alternate fuels, and to conduct biomedical research." But other ingredients are also required, he said, especially good educational programs. (Photo: Michael J. Epstein, '69)

Energy, Architecture, Computers, Management and More at M.I.T. Club of Cleveland Seminar

Is technology a future necessity? The M.I.T. Club of Cleveland held a symposium this fall to ponder this question, presenting a range of topics and speakers (distinguished alumni and non-alumni from the Cleveland area.) Two concurrent sessions were held throughout the day. Topics were varied, drawn from the speakers' expertise. Robert C. Seamans, Jr., Sc.D. '51, Dean of Engineering at M.I.T., gave the opening address.

He told the 285 attendants that technology is indeed a future necessity — but that it's important to understand the viewpoint of those that don't agree.

He defined technology: "the know-how required to produce a minicomputer, to build a steel rolling mill, or to construct an energy efficient office building. Specifically, technology is the research, design, manufacturing, construction, testing, and operational know-how required to make products and facilities to provide services."

A technological education can be exciting. He told the audience of his experience in witnessing the M.I.T. Course 2.70 design competition in which "student participation, interest, and enthusiasm has to be seen to be believed. As these students approach 'their moments of truth' (the title of the competition this year) they are learning about structural integrity, friction, momentum, electrical continuity, and reliability, all important concepts in technical education."

But is the application of scientific knowledge "the best or only approach to coping with the proliferation of economic and social problems?" asked the organizers of the symposium.

"Although many of these problems are universal, affecting both the industrial nations and the developing nations alike," answered Dr. Seamans, "the seminars at this symposium are primarily related to contemporary situations in the United States. In order to answer the question of how best to address our social or economic ills, we must first define them and put them into perspective."

"In order to answer the question of how best to address our social or economic ills, we must first define them and put them into perspective."

Technology in the United States

He described the United States' spectacular scientific investigation and technological development in the late 1940s, with intense crash war efforts; then the space program acceleration to compete with Russian successes. During this time, "major electronic industries in the United States were beginning to manufacture radios in Japan because they could no longer compete worldwide using their domestic plants," explained Dr. Seamans. What started as parts fabrication abroad spread until products were completely assembled (still carrying the labels of United States companies). "Today, 20 per cent of our domestic automotive market is satisfied by foreign engines and transmissions."

He spoke of our use of energy that has far outrun our ability to produce domestically, and other trends more sociologic than economic — "but equally alarming": our degrading of the environment, the increasing divorce rate, the multiplying crime rate. "Clearly, more than technology is required to restore confidence in our existing institutions."

He turned his thoughts to educational programs, to what should be included in an engineering school curriculum. "How far should we delve into the interaction between technology and society in the formal educational process?" asked Dr. Seamans, "Undoubtedly, more than we have to date," was his answer.

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The Trucking Industry Faces Tough Challenges

"The role of the motor vehicle industry in our society is often underestimated," explained James G. Musser, vice president of engineering and forward product development at White Motor Corp. He spoke at the M.I.T. Club of Cleveland seminar, "Technology: a Future Necessity?" this fall.

"Motor vehicle and related industries provided jobs for some 14 million Americans involved in the manufacturing, distributing, servicing, or commercial use of the nation's 149.1 million vehicle fleet; those vehicles traveled some 1.5 trillion miles last year, transporting goods and providing 96 per cent of all personal transportation in the United States," he explains.

Mr. Musser is concerned with the truck segment of that fleet: about 31.4 million vehicles. Their role is significant — they carried more than 600 billion ton-miles of inter-city freight last year, he says. "Trucks haul virtually all livestock, 89 per cent of all fruits and vegetables to major markets, and 57 per cent of all inter-city freight shipments of manufactured goods, excluding petroleum and coal products," he explains.

The truck industry must concern itself with safely moving this huge cargo using a minimum of energy and creating the smallest possible exhaust emissions and noise. But its most important challenge is energy conservation.

Necessary Improvements in Fuel Economy

A voluntary truck and bus fuel economy program joins motor carriers, manufacturers, labor and trade associations with the Department of Transportation and other government agencies to work toward fuel savings. The savings resulting from the installation and use of fuel-efficient options are tracked through the program, explains Mr. Musser. "Since 1973 more than 2.5 billion gallons of fuel have been saved through the purchase and use of variable fan drives, radial tires, aerodynamic devices and larger numbers of fuel efficient diesel engines," he adds. Total fuel savings in 1978 was 1.2 billion gallons — nearly twice the savings of the previous year.

Heavy trucks may seem to get low miles per gallon, but this is deceiving, explains Mr. Musser. The freight that is being hauled per gallon is a crucial consideration: "a 29-miles-per-gallon pickup hauls less than 9 ton-miles/gallon, whereas the heavy truck (a typical over-the-road tractor-trailer combination that gets less than 6 miles per gallon) hauls over 140 ton-miles/gallon. "The heavy truck is 16 times more efficient." Mr. Musser emphasizes.

There is a reason. Diesel engine manufacturers have developed higher torque, lower R.P.M. engines that burn less fuel without sacrificing efficiency (and the diesel is inherently more efficient than a gasoline engine.) These engines are used with transmissions and axles that optimize the gains.

The tremendous aerodynamic turbulence and resistance created by the box-like nose of a typical dry freight trailer was of little concern in the era of cheap fuel. Today, devices mounted on the roofs of the cabs bend air currents around the sides and over the top of the trailer. They improve mileage by as much as 12 per cent, says Mr. Musser.

Other improvements are now part of most new trucks coming out of factories. An example is clutch-type fans that operate when needed. "When the truck is moving, the fan is rarely engaged," explains Mr. Musser, "and the horse-power that was required to drive it is now used more efficiently to turn the truck's wheels." Radial tires also help save fuel, because of their easier rolling characteristics.

An operator's fuel bill can be cut by as much as 40 per cent by using lower R.P.M. engines, air deflectors, clutch fans and radial tires. "Combined with the 55 mile per hour speed limit, that resulted in an industry-wide, nation-wide saving of 1.2 billion gallons of fuel in 1978 as reported by the department of transportation," says Mr. Musser.

But Mr. Musser cautions that there is still a long way to go and he sees no more "instant" fuel saving devices easily applicable to the present vehicles. So it is necessary to go back to the basics of truck engineering, he says, "to achieve better fuel economy without adversely affecting operating efficiency." White Motor Corp. focuses on reducing weight and improving aerodynamics.

Mr. Musser describes their results: "In the 1980s you will be seeing increased use of new lightweight alloys as well as more plastics. You may also expect to see the use of some exotic materials, some composite materials, and some lighter structural forms." Some changes may also come in the aerodynamic shape of trucks — but that, he says, depends on how fast and how far state and federal lawmakers move to ease inhibiting restrictions.

Jumble of Government Regulations

"Government regulation will have more effect on how we design our trucks and how we operate them in the 1980s than any other factor or force," says Mr. Musser. This is not a small influence — there are now 24 government agencies involved in advising the trucking industry.

Mr. Musser is critical of the many rules imposed "We are obliged to question regulations that seem to contradict other regulations." These rules are difficult to adhere to, at best. But of most immediate concern are regulations slated for 1982 or 1983, lowering noise levels and reducing emissions. "The noise regulation will cut drive-by sound from the present 83 decibels to 80 — the equivalent of a 50 per cent noise reduction. At almost the same time, the emission of particulates and nitrous oxides are to be substantially lowered," explains Mr. Musser.

James G. Musser

"The Environmental Protection Agency has proposed lowering noise levels by another 50 percent in the late 1980s." He pointed out that that level is softer than his speaking voice in front of the lecture hall. Such regulation would probably mean total redesign and total encapsulation of engines in sound absorbing cocoons, with resulting appreciably higher maintenance costs, he added.

Plug in Diagnostic Systems

Other future changes not attributable to government regulation were described by Mr. Musser. "By the mid-1980s," he says, "we expect to be able to equip our trucks with plug-in diagnostic systems that will permit a mechanic to pin-point a problem in a matter of minutes as opposed to the hours sometimes required now by the trial and error method. Much more use will be made of solid state circuitry, eliminating many of the electrical problems that are inherent to today's complex truck wiring systems. And driver environment — the seating package, cab heating and cooling, ride characteristics, and general driver comfort — all will be greatly improved in the next ten years," says Mr. Musser.

Cost efficiency presents a final challenge to the truck manufacturing industry. (Truck prices have nearly tripled in the past ten years — the plainest heavy-duty tractor now costs nearly $60,000.) White Motor Corp. uses a "family" approach to truck building, explains Mr. Musser. They have adapted the same basic design to all three primary models and developed 80 percent interchangeability of parts between models. — *M.L.*

Alternative Sources of Energy Conservation

J. Steward Fordyce, Ph.D. '59, chief of the Electrochemistry Branch of N.A.S.A. Lewis Research Center, described technologies to lesson our dependence on oil resources such as electrical energy storage for utilities. A large variation occurs in the load of a typical utility, he explained. Storage in a utility system allows the reserve overnight to be used the next day. In various utilities that don't generate their own power, but do distribute it, one could buy off the peak power and store it for use later. He also discussed a low-cost approach to energy storage, the redox energy storage system.

He described the electric automobile and its usefulness. The ability to go 80 miles in one day meets 95 per cent of a person's needs, he explained. Battery technology will now only give you 40-50 miles — not very attractive. But by 1982, the technology will be available to allow ranges of 85-100 miles. And longer trips will be possible by 1986, he explained.

We can teach people problem-solving, but not how to behave. A university can't educate people to assume the agony and ecstasy of the responsibility for results.

Architecture: From Art to a Look of Common Things

Peter Van Dijk, M. Arch. '56, a partner in charge of design at Dalton, van Dijk, Johnson and Partners, discussed architecture. There is a trend toward building cities like an Italian hill town, he explained. This grouping of buildings within a small area leaves the countryside alone and gives the inhabitants the advantages of concentrated living, he said.

He traced the history of architecture and projected it into the future. He contrasted many different schools and tastes in modern architecture, from a kind of pure architecture, or "architecture as art" (where beauty is more important than function), to an aesthetic that mimics common things, with no attempt to make the architecture look pretty. He discussed the great interest today in the restoration and re-use of older buildings to save energy and money, and — more than that — to keep what is familiar. Repairing and refueling provides a much healthier environment than replacing old grandeur with dull, new buildings, he said.

Education Alone Can't Produce Managers

Theodore M. Alfred, Ph.D. '63, dean of the School of Management of Case Western Reserve University, suggested that although there is a tremendous growth in M.B.A. students and programs (the number of M.B.A. graduates has tripled in a ten-year period), in his view, education alone can't produce managers. Managers are defined, he explains, by what they *do*, not by their education. They must participate in complex decision-making. We can teach people problem-solving, he said, but not how to behave. A university can't educate people to assume the agony and ecstasy of the responsibility for results, he emphasized. And he recalled Mark Twain's remark, "I never let my schooling interfere with my education." "What we can't do in formal education is what goes on informally and continuously in the company," he added.

Asked about the differences between management and leadership, Dr. Alfred cited De Gaulle's phrase, the "mystique" of leadership — a quality of charisma and creativity that is hard to teach. And it is much more necessary than being a good manager, he said. — *M.L.*

Communications to bring M.I.T.'s best friends even closer — so they in turn can help make more good friends for the Institute. In the pictures: (this page) Bruce Anderson, '63, (left) with Claude W. Brenner, '47, president of the Alumni Association; and (opposite) Robert M. Franklin, '34, hearing the undergraduate side during the Class Day/A.O.C. "picnic" in Walker Memorial because of rain. (Photo right: Mark H. Sloan, '81)

Alumni Officers' Conference: Charting a Two-Way Street Between M.I.T. and its Family

Its planners think of the annual Alumni Officers' Conference as the launching pad for a new year of alumni activities in support of M.I.T.

It is, but that oversimplifies things a bit.

Because M.I.T. is multi-faceted, and because the interests and expectations of alumni and their *alma mater* range widely, the 1979 A.O.C.'s launching pad was paved with many different stones:

☐ An all-day Alumni Fund workshop on the programs and techniques by which the fund will reach its goals for 1980 — a major effort to reach at least 1,000 potential donors in personal solicitation.

☐ An evening of entertainment in a particularly rewarding M.I.T. tradition: Professor Harold E. Edgerton, Sc.D.'31, on underwater exploration — especially the search for and exploration of the remains of the *Monitor*.

☐ An afternoon with the faculty: reports on high-energy physics (Professor Francis E. Low), the politics of the People's Republic of China (Professor Lucian W. Pye), and new developments in biomedical engineering (Professor Edward W. Merrill, Sc.D.'47).

☐ Workshops on alumni relations (including communications) and admissions — the role and operations of the Educational Council.

☐ The Robert H. Richards Lecture by Allan J. MacEachen, '53, deputy leader of the opposition in Canada who is opposition leader in Canada's House of Commons.

It was a busy two days, enriched on Saturday, September 29, by the confluence of A.O.C. and Class Day. The most visible celebration of this conjunction was a roast beef picnic luncheon (served in Walker Memorial because of inclement weather) which brought alumni and students together in unprecedented numbers.

Honors for the Faithful Toilers

As a launching pad for alumni activity in 1979-80, the Alumni Officers Conference was paved with many different stones.

Bronze Beavers — the Alumni Association's highest award for service by its members to M.I.T. — were given to six alumni: Edward J. Hanley, '24, Peter M. Bernays, '39, Hugh Parker, '43, S. James Goldstein, '46, Jack C. Page, '48, and Thomas H. Farquhar, '60.

And there was a seventh Bronze Beaver presentation — to President Jerome B. Wiesner, as expression of the alumni's understanding of his immense contributions to M.I.T. as well as an appreciation of his support of the Alumni Association: "Always sensitive to the needs of alumni, he has been enthusiastically supportive whenever his advice or assistance was sought. To the lasting benefit of the association, his leadership has been direct yet extraordinarily human," said the citation.

In addition, there were George B. Morgan Awards for "extraordinary service to the Educational Council" to nine alumni: Walter L. Helmreich, '40, Ann Arbor, Mich.; Albert L. Kaye, '31, Chicago; Paul A. Lux, '52, St. Louis; Edwin Newton, '58, Rochester-Buffalo; James S. Offutt, '26, Chicago; Victor Ransom, '48, New Jersey; Beaumert Whitton, '33, Charlotte, N.C.; Lewis R. Aldrich, Jr., '29, Montana; and Everett P. Weatherly, Jr., '29, Kansas City. George B. Morgan, '20, who was referred to as the "dean" of educational counselors, watched proudly as his example was honored.

And a second new class of citations, the Lobdell Awards (for the late Harold E. Lobdell, '17) for valuable service to M.I.T. in a single area of Alumni Association activity. The presentations are being made locally, but the list was announced with pride by Claude W. Brenner, '17, president of the Alumni Association, at the awards ceremony: Eugene Becken, '52, Carroll J. Brown, '46, Vito A. Caravito, '62, Raymond Danon, '58, Myron A. Exelbert,

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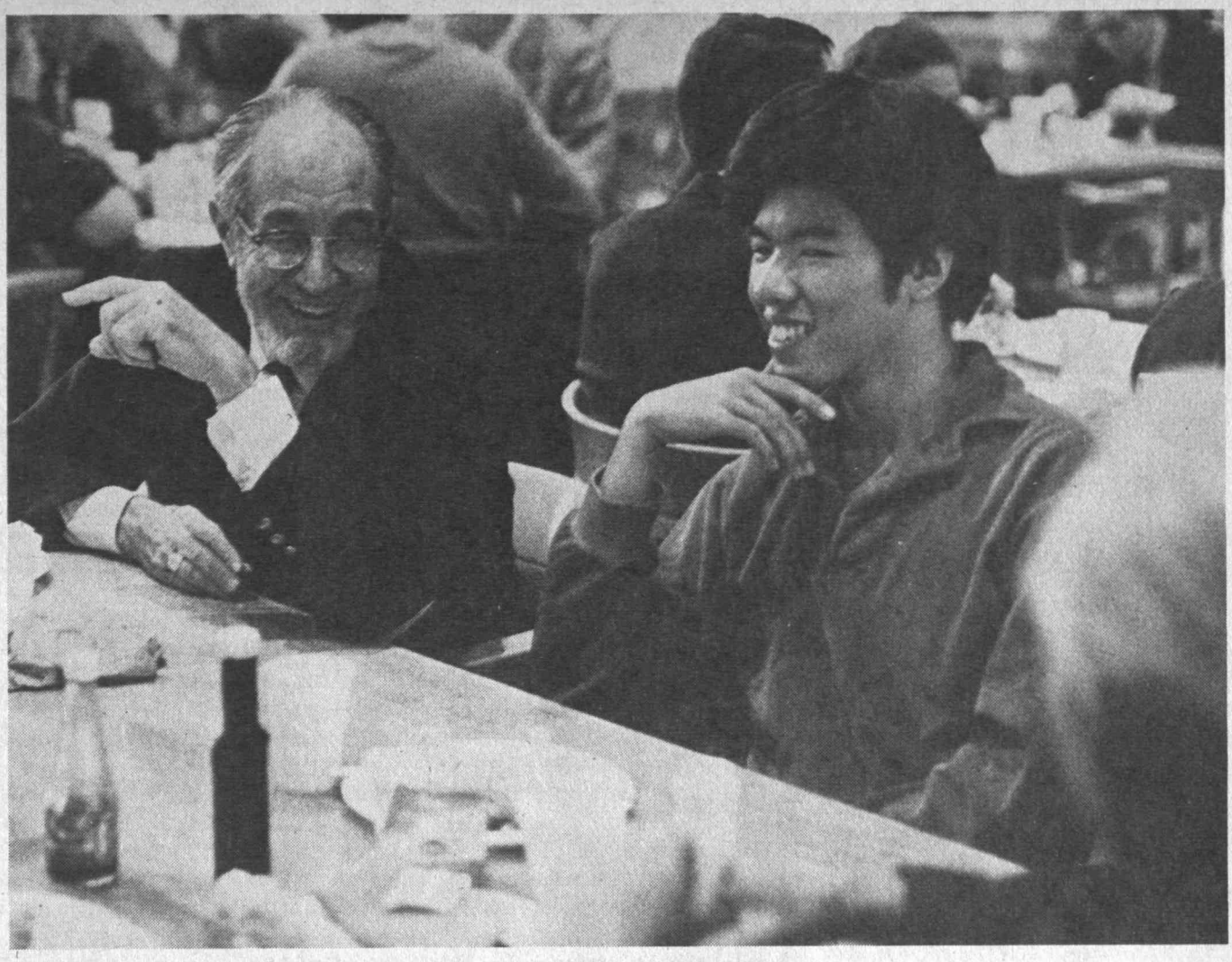


MacEachen: A World Dialogue Needed on the Energy Shortage

Can technology reach into its bottomless bag of tricks for a new solution to the energy shortage?

Most people act as if they expected that.

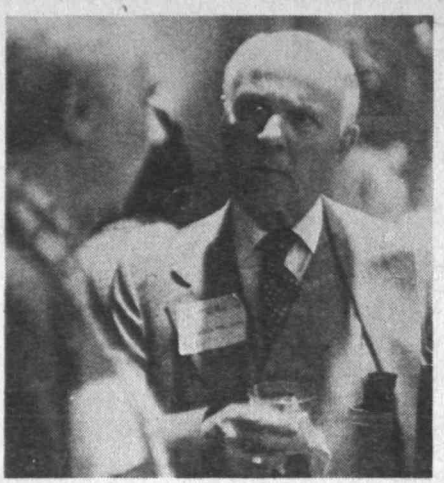
But it's a pipedream, says Allan J. MacEachen, '53, who is deputy leader of the opposition in Canada and opposition leader in Canada's House of Commons. The energy shortage represents a radical shift in world political and economic power, and the challenge to the industrial nations is not to confront the new seats of power but to adapt to the new conditions in which they find themselves.

Indeed, said Mr. MacEachen in his Robert H. Richards Lecture to the Alumni Officers' Conference on September 29, the energy shortage is a truly international problem: "nowhere else do all the interests of the world come together — developing and developed countries, O.P.E.C. and non-O.P.E.C. nations." And it's a "disappointment" to him that the international community has been able to do so little — a failure which marks "a very basic weakness in our international machinery."

Problems lie on all sides of the complex issue. Developed nations — particularly the U.S. — have been withholding nuclear energy technology from the developing world. But that's wrong, said Mr. MacEachen. "We have a duty to make nuclear technology available to energy-poor countries. . . . Nuclear exports are a legitimate economic goal."

O.P.E.C. has made no attempt to discuss the question of present and future oil prices, thus plunging the rest of the world into economic uncertainty. "The West must press for open negotiation on this issue," Mr. MacEachen declared. But what about price controls which superimpose political controversy on the issue of oil prices? asked President Jerome B. Wiesner. Such political controls can be blamed on O.P.E.C. now, replied Mr. MacEachen: government intervention into market mechanisms is inevitable "in the face of gross distortions of price structures by O.P.E.C."

Though the energy shortage is a worldwide issue, the many economic and political interests which surround it throughout the world have no place to come together for reconciliation, said Allan J. MacEachen, '53, in his Robert H. Richards Lecture before the Alumni Officers' Conference on September 29. Such an international dialogue has been made impossible, he said, by the refusal of the O.P.E.C. nations to make the question of oil pricing part of the agenda for world negotiations.



Plotting the 1980 Alumni Fund. Christian J. Matthew, '43, began his active work as chairman of the Alumni Fund Board during the 1979 Alumni Officers' Conference, and he spent most of the A.O.C. "learning the ropes" and enlisting workers. Here he's visiting with James O. McDonough, '43 (left).

'63, Arnold A. Kramer, '52, Robert Lindquist, '51, Joseph P. McBrien, '31, Terence K. McMahon, '57, Philip L. Molten, '55, Gregory L. Schaffer, '65, and Frank R. Shaw, '24.

Expectations by Alumni — and by M.I.T.

The dialogue between M.I.T. and its alumni flows both ways, said Mr. Brenner in his address to the A.O.C. — expectations of M.I.T. by its alumni, and needs from them by the institution.

In Mr. Brenner's view, the expectations center on the maintenance of standards. "M.I.T. is a model," he said; "it stands alone in higher education. No other institution is ever mentioned in the same breath as M.I.T. And we like that.

"The quality of the education that M.I.T. offers, together with the demands that it places on the student, are not diminished; and the alumni expect this ever to be so," he declared. "And we also look to M.I.T. to be concerned with our professional needs — with our continuing education, so that we can maintain our professional standards just as we expect academic standards to be maintained." Mr. Brenner admitted that the latter is a "demand not easily met," but he pledged the Alumni Association's continuing concern and efforts.

The challenge of alumni support to M.I.T., principally by strengthening the Alumni Fund, was left to Christian J. Matthew, '43, chairman of the Alumni Fund Board. He began with an upbeat report: the 1979 Fund was the first to exceed $5 million, with a total of $5,158,188 — an important part of the $15.9 million of total 1978-79 alumni giving to the Institute. There were gifts to the Alumni Fund from 21,891 alumni.

Two improvements in areas on which the Alumni Fund concentrated in 1978-79:

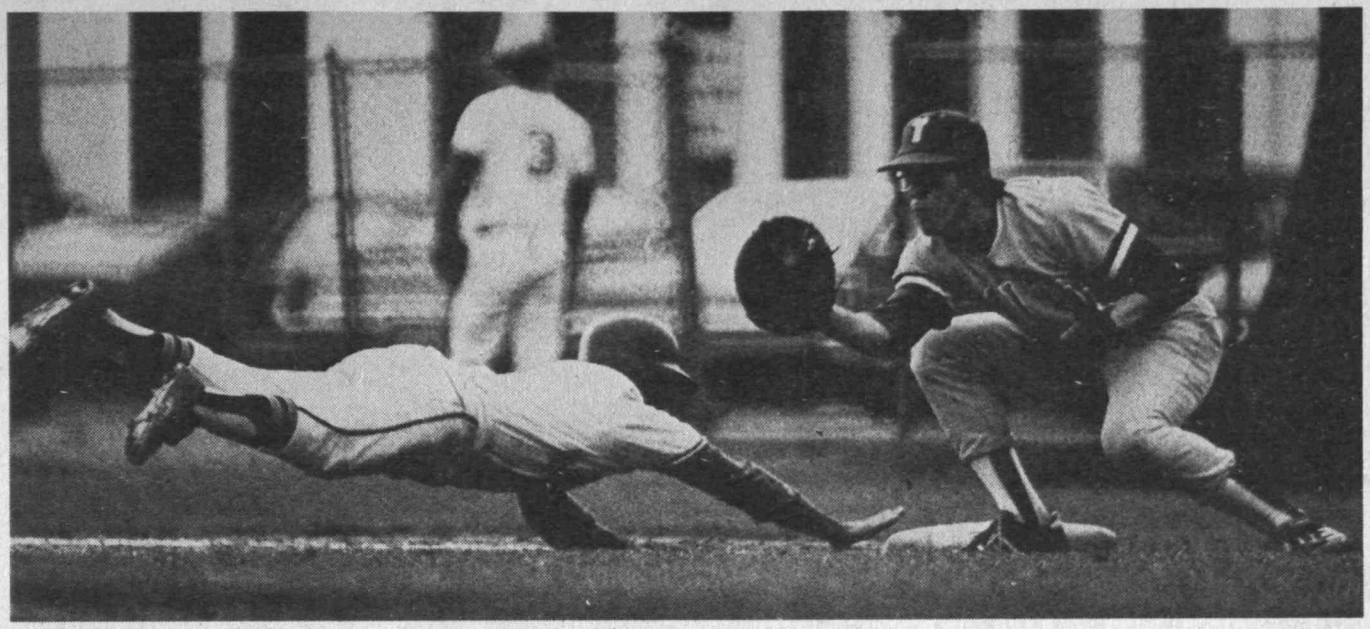
☐ The number of gifts of $100 or more increased by 231 in the 1979 fund, but "gift upgrading remains a major goal," said Mr. Matthew.

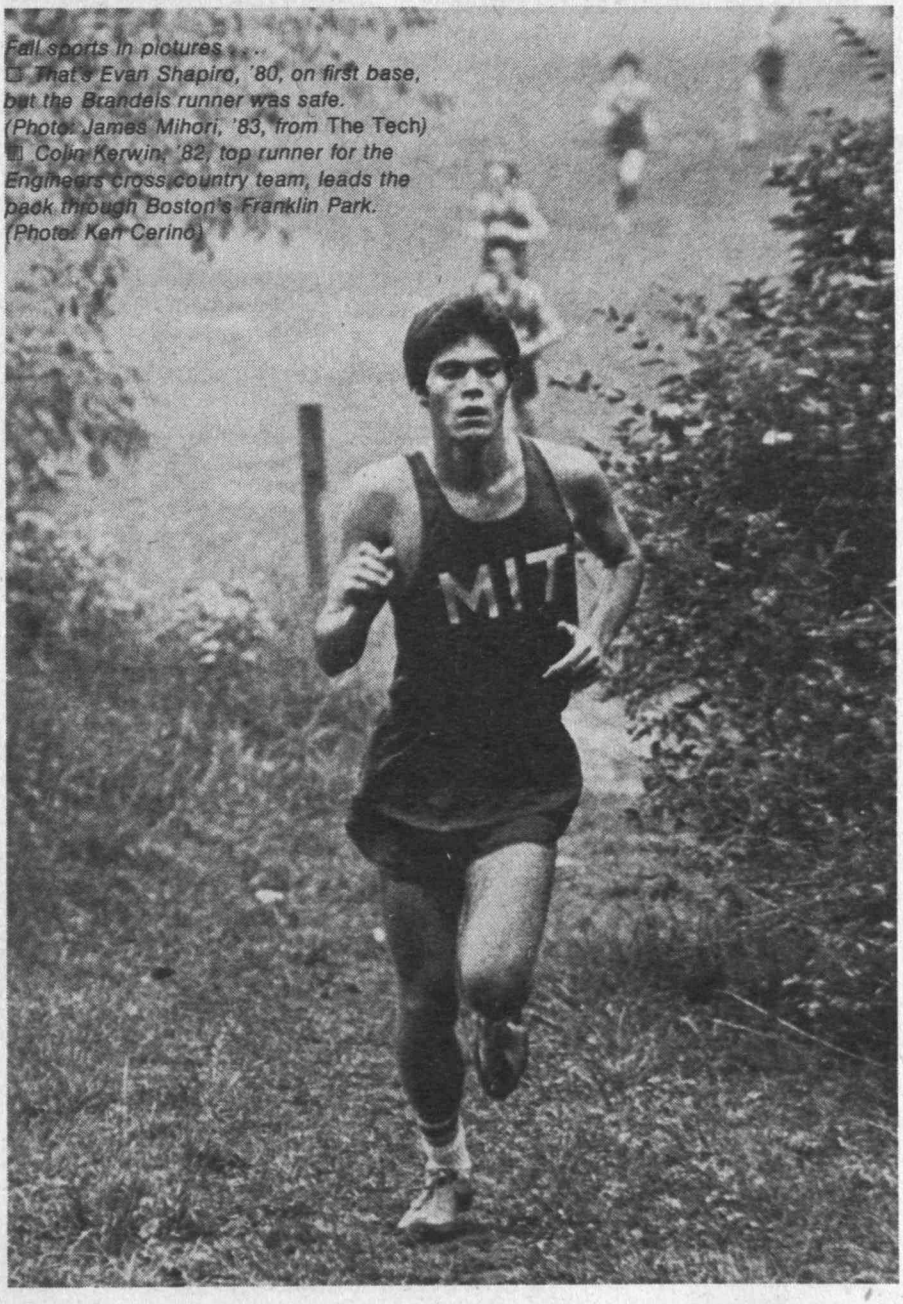
☐ The number of "lybunts" (gave *l*ast *y*ear *b*ut *n*ot *t*his) was reduced by 804 in the 1979 fund; that's a gain of 4 per cent in conversion over 1977-78.

But despite this progress, the 1980 Alumni Fund has its work cut out for it, said Mr. Matthew. In the past decade, he said, the number of donors to the fund has remained "virtually static," though the total number of M.I.T. alumni has increased; so participation in the fund is down from 44 per cent in 1970 to 36 per cent in 1978-79. And the total of Alumni Fund giving has "reached a plateau" in the same period, said Mr. Matthew — partly because only 19 per cent of donors give $100 or more and the median gift is only $25.

"Gift upgrading" is the technical term for the program to which Mr. Matthew pledged the 1980 Alumni Fund. It's "inconceivable," he said, that most M.I.T. alumni cannot afford $2 a week — $100 a year. With help from Thomas H. Farquhar, '60, there will be a major effort in personal solicitation — alumni calling alumni in behalf of the 1980 Alumni Fund. Heretofore, such efforts have been "volunteer-limited," Mr. Farquhar said: "the limiting factor has been the number of people who will go out and do it." A recruitment program combined with special training was already being organized as Mr. Farquhar spoke to the A.O.C. audience.

One major fund-raising achievement of 1978-79 was reported by Walter A. Rosenblith, provost: completion of the $1 million Ellen Swallow Richards Professorship. The idea is to provide a professorship which will be "an inspiration to all women" at M.I.T. The project was embraced enthusiastically by M.I.T. alumnae, and Professor Rosenblith said his role had been only that of "an enthusiastic lobbyist." — *J.M.*





Fall sports in pictures . . .
☐ That's Evan Shapiro, '80, on first base, but the Brandeis runner was safe. (Photo: James Mihori, '83, from The Tech*)*
☐ Colin Kerwin, '82, top runner for the Engineers cross country team, leads the pack through Boston's Franklin Park. (Photo: Ken Cerino)

Fall Sports Report:
The First Football Win
Since 1900 Turns All Eyes

In only the second year of its rejuvenation, football — though still a "club" sport — dominated the 1979 fall sports season with a broad base of support and campus visibility. Glenn P. Strehle, '58, treasurer of the Institute, says it's "the beginning of a new M.I.T. tradition: that we *will* have football."

Under that bright spotlight, the football team turned in a performance that satisfied most of its many fans — three wins in seven starts. Coach Dwight Smith's club team was victorious over Norwalk Community (18-8), Roger Williams (20-0), and N.Y. Maritime (37-14). Quarterback Bruce Wrobel, '80, was one of the top players in the National Collegiate Football Association after completing 72 of 141 pass attempts for 987 yards and three touchdowns. Next year's schedule includes a possible game with Cal Tech in the Rose Bowl in Pasadena.

Since last year's football team had lost all six of its games, this year's season opener against Norwalk was the first M.I.T. win in football since 1900.

300 Athletes, 150 Games

Meanwhile, some 300 student-athletes competed on 16 varsity and junior varsity teams in M.I.T.'s more traditional sports. Several outstanding individual and team performances were recorded in more than 150 contests. Here's what happened:

Cross country: Coach Chris Lane's team finished with a 4-2-1 record and competed in the N.C.A.A. Division III championships in Moline, Ill. The team's rare tie came against highly-regarded Lowell (28-28). Top runner for the Engineers was sophomore Colin Kerwin, who placed second in three races.

Women's field hockey: Julie Neuringer, '81, scored 12 of Tech's 20 goals in leading

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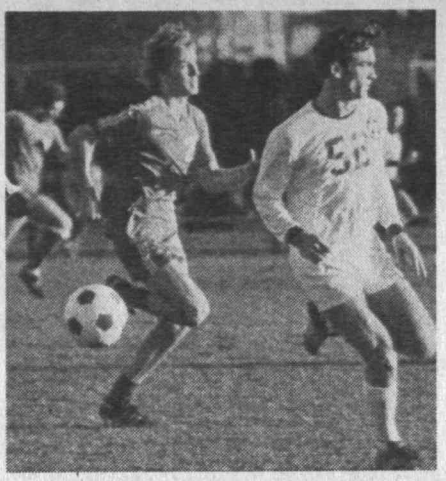
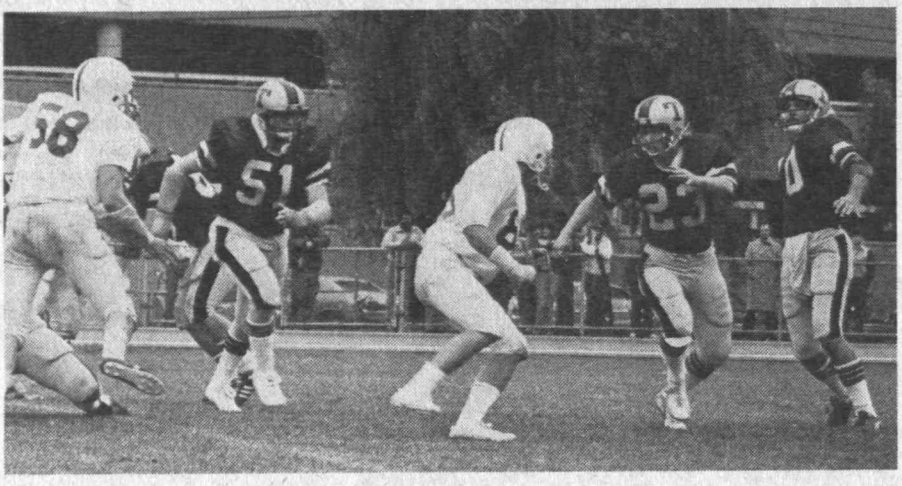




Clockwise from top left:
☐ *Rosemarie Wesson, '81, sends her shot flying over University of Massachusetts defender during the homecoming volleyball match in du Pont gym (Photo: James J. Snyder, courtesy of* Technique)
☐ *M.I.T.'s Jay Walsh, '81, (52) and Boston University defender during soccer action in Steinbrenner Stadium. Division I Terriers blanked Tech, 2-0. (Photo: Ken Cerino)*
☐ *Quarterback Bruce Wrobel, '79, drops back to pass behind the protection of Jeff Olson, '81, (23). Walt Crosby, '80, (51) moves over for additional blocking. Engineers dumped New York Maritime in the homecoming contest, 37-14. (Photo: James J. Snyder, courtesy* Technique)
☐ *M.I.T. crew team gets ready for an afternoon practice on the Charles River. (Photo: John Borland, '80)*

the team to its best record (6-4-2) in three years of varsity competition. Other top players on coach Debbie Clum's squad were Connie West, '80, Emmy Behlau, '81, and Lisa Richardson, '81.

Golf: Senior Doug Parigian was the number-one player on coach Jack Barry's 4-1 team last fall; he averaged 80.0 for five rounds and had a season low of 74 against St. Anselm's.

Sailing: Coach Hatch Brown's men's team finished in the top five in eleven of 17 regattas and captured the Three-Man Crew Race on the Charles River, the Tufts Invitational, and the overnight Corinthians Ocean Race on the Long Island Sound. Top skippers were captain Bill Dalton, '80, and Penn Edmonds '83.

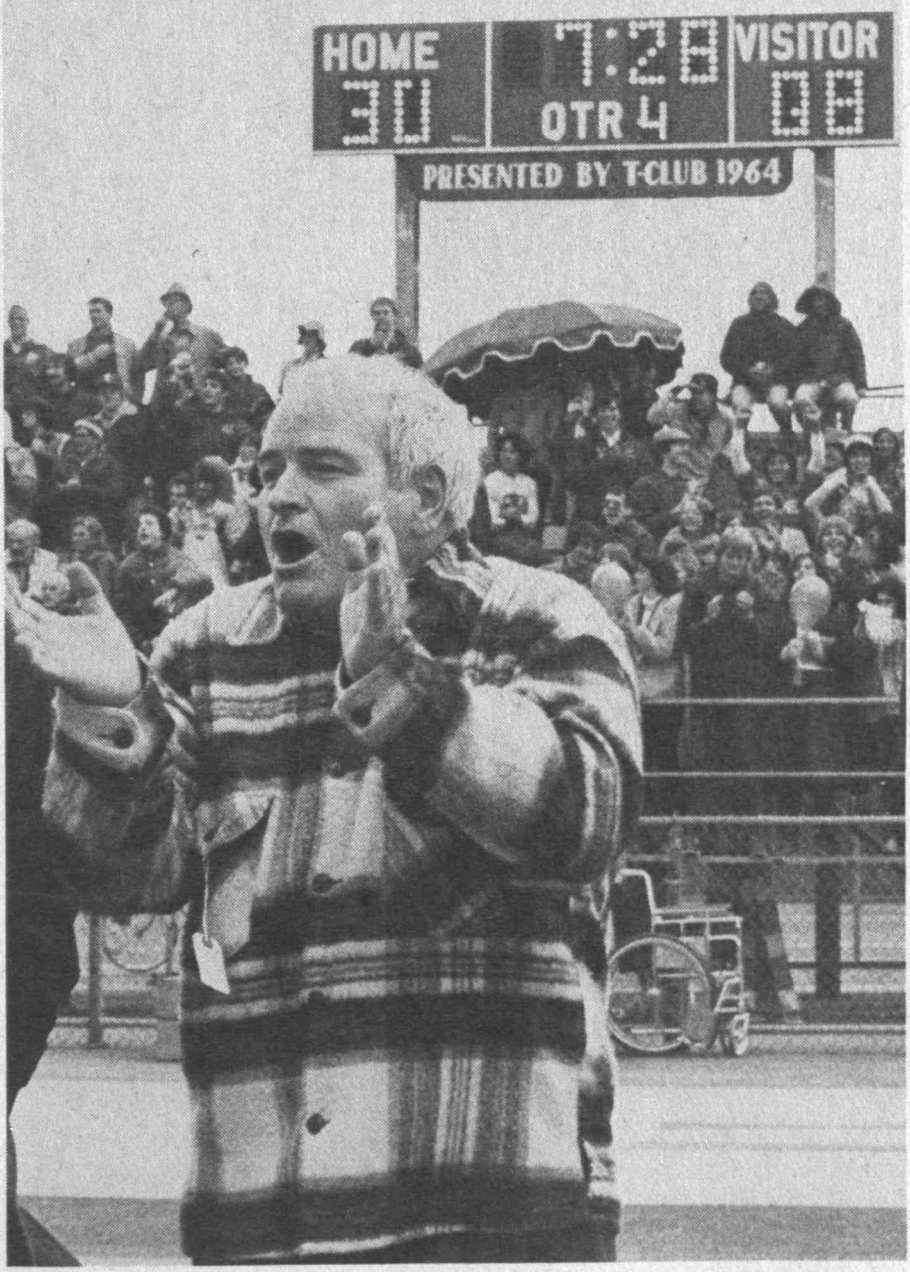
Soccer: The Engineers suffered through their worst season since 1974, finishing with a 2-10-1 record. Coach Walt Alessi's young team won the season opener against Clark (3-2) and the finale at Coast Guard (2-0), but in between dropped five games each by one goal. Two members of the team, forward Jay Walsh, '81, and fullback John Busa, '83, were named to the 1979 Greater Boston League all-stars.

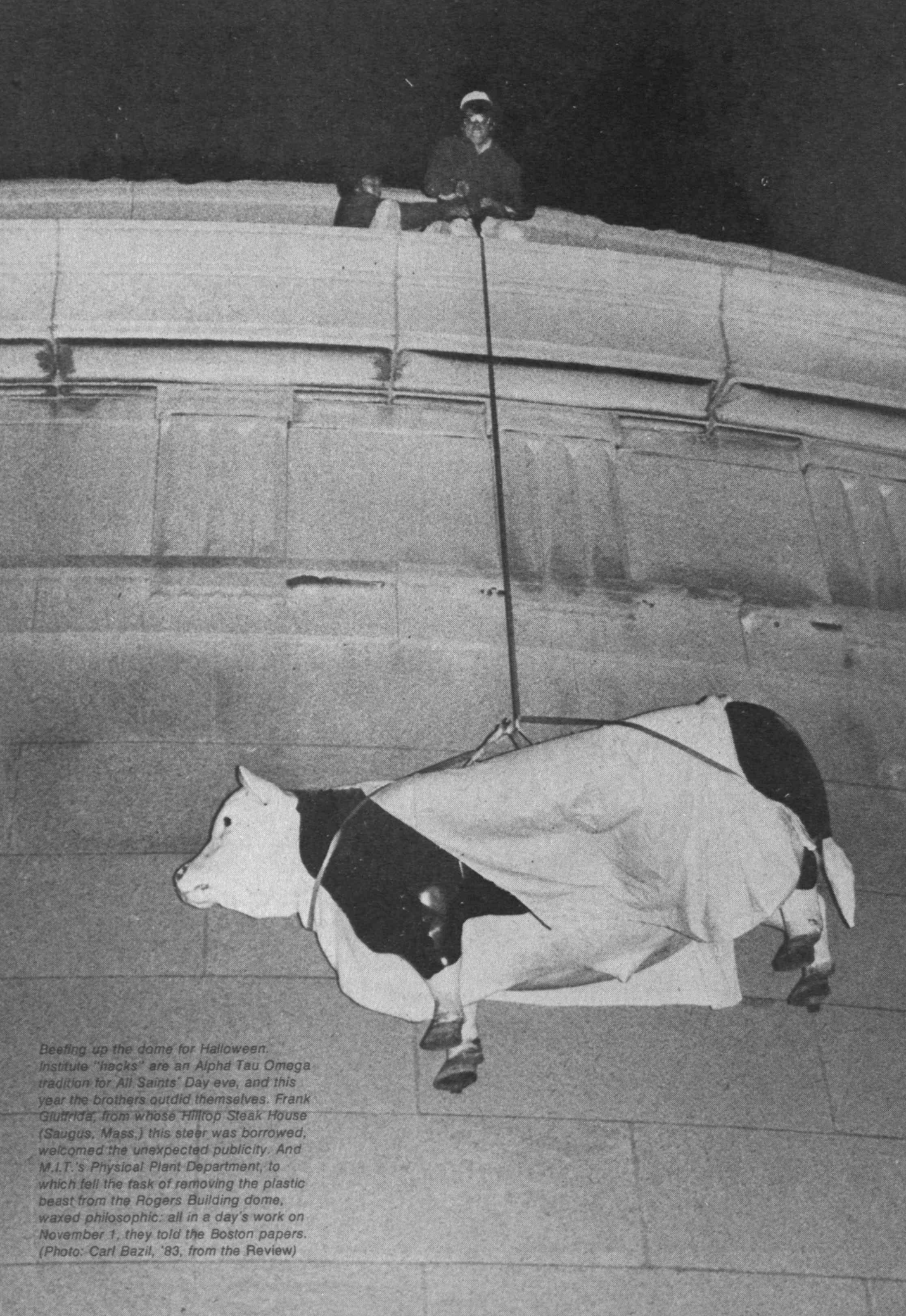
Tennis: Coach Ed Crocker's men's team was 0-3 in an abbreviated season while the women, under coach Manny Weiss, were 3-7. Karen Haug, '82, won the Massachusetts Division III singles championship.

Water polo: With a fine 9-8 record against strong competition, the Engineers were ranked third in the New England coaches' poll; and the coaches were right: this talented squad finished third for the second straight year in the New England championships. A victory over Harvard was among the high points of the season; three top players were John Dieken, '80, Tim Eggert, '80, and Mark Huntzinger, '81.

Women's volleyball: Despite the loss of captain Kathy Chrien, '81, with a foot injury early in the season, coach Dave Castanon's team posted a 7-9 record and finished third in the Massachusetts A.I.A.W. Division II tournament. The Association for Intercollegiate Athletics for Women is the nation's largest governing board of athletics, with 916 active member institutions. Similar to the National Collegiate Athletic Association (N.C.A.A.) for men, the A.I.A.W. is broken into three divisions on the state, regional, and national levels. M.I.T.'s women compete in Division III in basketball, fencing, field hockey, gymnastics, softball, and tennis, and in Division II in volleyball. Jane Betts, M.I.T. assistant athletic director, is president of the Massachusetts A.I.A.W. for 1979-80. — *Ken Cerino, Director of Sports Information.*

Paul Gray, '54, M.I.T. President elect, at the Homecoming football game this fall. Cheerleaders (right) joined him in their enthusiasm. Photos: right, Mathew B. Alschuler, '83; below: James J. Snyder, courtesy Technique





Beefing up the dome for Halloween. Institute "hacks" are an Alpha Tau Omega tradition for All Saints' Day eve, and this year the brothers outdid themselves. Frank Giuffrida, from whose Hilltop Steak House (Saugus, Mass.) this steer was borrowed, welcomed the unexpected publicity. And M.I.T.'s Physical Plant Department, to which fell the task of removing the plastic beast from the Rogers Building dome, waxed philosophic: all in a day's work on November 1, they told the Boston papers. (Photo: Carl Bazil, '83, from the Review)

Mexico in March: The Fiesta Plans Five Days in Morelia

For its 32nd running, the annual M.I.T. Fiesta in Mexico will go to Morelia, a Spanish-colonial city founded in 1541 180 miles west of Mexico City. State-side alumni are invited to join sponsoring members of the M.I.T. Club of Mexico for a five-day celebration at the Villa Montana Garden Hotel.

On the schedule: a full-day excursion to Patzcuaro, Janitzio, and Santa Clara del Cobre, noted for copper handcrafts; a half-day tour of Morelia and a visit to its Handcrafts Museum in the Convent of San Fernando; and folklore dances sponsored by the Morelia Tourism Delegation.

Visitors will assemble during the day on Thursday, March 20, at the Hotel Maria Isabel Sheraton in Mexico City; there will be bus transportation to Morelia early in the morning on Friday, with return to Mexico City early on Tuesday, March 25. The cost, including air transportation from New York and all expenses in Mexico, will be about $600 per person, double occupancy. For further information and reservations: Hector M. Orozco, '45, president of the M.I.T. Club of Mexico, Sierra Gorda 540, Mexico 10, D.F.

Pi Lambda Phi Celebrates 60th Anniversary

On February 28, 1920, Phi Beta Delta fraternity granted a charter to a group of M.I.T. men to found the Massachusetts Theta Chapter. In 1941, a merger occurred with another national fraternity and the current Massachusetts Theta Chapter of Pi Lambda Phi was formed. The house will be celebrating the anniversary of the original charter with a Pi Lambda Phi Alumni Reunion weekend this Washington's Birthday weekend, February 16-18, 1980. A 60th Anniversary fund raising drive is also underway to restore the chapter room to its original condition.

Alumni are urged to write to the house at 450 Beacon St., Boston, Mass. 02115. For more information, alumni may contact Eric Brown, '81, Alumni Relations Chairman, (617) 267-5451.

Estimated Research Up 11 Per Cent

Preliminary estimates place sponsored research volume on the campus during the current year at just over $158 million; that's up from $141.3 million for the 1978-79 year — an increase of about 11.4 per cent, excluding major subcontracts.

Among academic departments, estimated research volumes are highest for nutrition and food science ($7.0 million), chemistry ($6.8 million), biology ($6.6 million), earth and planetary science ($6.0 million), materials science and engineering ($5.0 million), mechanical engineering ($4.3 million), and aeronautics and astronautics ($4.1 million). Research estimates for the interdepartmental laboratories include $12 million for the Laboratory for Nuclear Science, $10.7 million for the National Magnet Laboratory, $10.5 million for the Energy Laboratory, $9.7 million for the Research Laboratory for Electronics; and $5.8 million for the Plasma Fusion Center.

The largest sponsor — by far — will be the Department of Energy ($40.7 million), with the National Science Foundation ($25.1 million) and the Department of Health, Education and Welfare ($24.3 million) nearly tied for second.

The figures are from Robert M. Dankese, M.I.T.'s associate budget director.

Youth for the Corporation

Members of recent graduating classes have been invited by Shirley A. Jackson, '68, to contribute suggestions toward a slate of recent or current graduates to take a seat on the M.I.T. Corporation beginning next July 1. For further information: Richard A. Knight, secretary of the Alumni Association, M.I.T. Room 10-140.

Kresge's Roof Is Falling Down? No, but Urgent Repairs Close the Hall

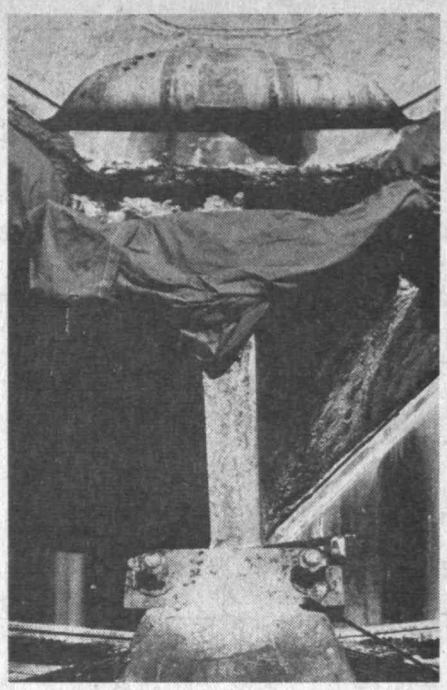
Kresge Auditorium was closed abruptly late in September when serious structural damage due to weathering was found in the west abutment.

Water, seeping under the lead roof installed in 1963, had penetrated and cracked the concrete, exposing the reinforcing bars and raising fears for the integrity of the structure. But no deformation had taken place, and repairs are now beginning.

Meanwhile, confronting the prospect of Kresge being closed for at least the rest of the academic year, countless student groups and events have scrambled to find new places to perform. A "crushing" blow to the creative arts, said *The Tech*. A "very rocky" situation for the drama program, says Professor Robert Scanlan.

Dramashop's first evening of one-act plays was held at Agassiz Theater, Radcliffe; Harvard's Loeb Theater has been offered to the M.I.T. group for major productions. The Symphony Orchestra and Concert Band are rehearsing and playing concerts in Walker Memorial. The student Musical Theater Guild, already in debt, postponed its intended fall show, "Anything Goes," which was several weeks into production.

Repairs to Kresge's roof began early in November with the installation of temporary steel columns to relieve (and even) the loads on the abutments. The lead covering is to be peeled away, and with it layers of light-weight concrete, membrane, and insulation underneath. There will be a temporary waterproof covering over the concrete shell for the winter, while repairs are made to the abutments; then new insulation and finally a copper (instead of lead) exterior sheathing will be applied.



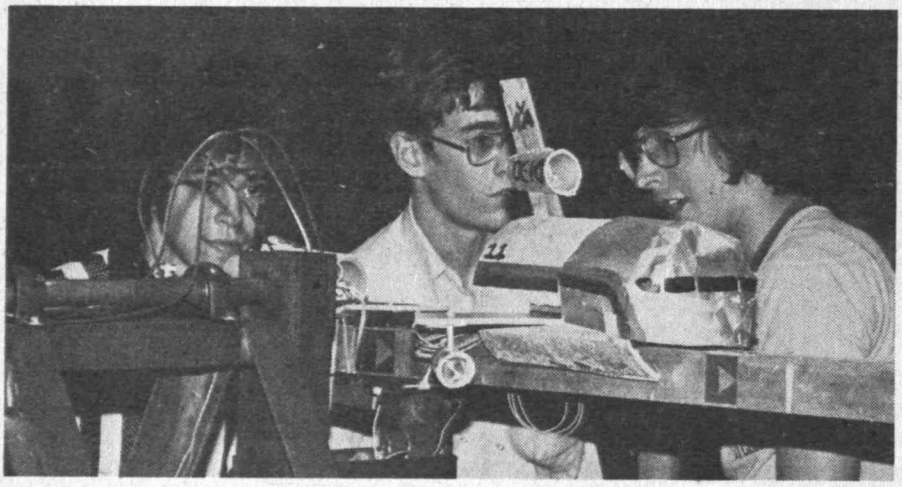
Trouble in Kresge Auditorium. *Lead sheathing peeled back reveals deterioration in the west abutment; when the problem was discovered late in September, Kresge was abruptly – and indefinitely – closed. "The roof is the building," says William R. Dickson, '56, director of physical plant; it's one-eighth of a sphere – a concrete shell as thin as 3½ inches at the peak, resting on three abutments such as the one in the picture. With the roof shored up, repairs are now in progress; there was no deformation, but Kresge will be closed for at least the rest of the academic year. (Photo: Donna J. Dudzik)*

Twenty-Year Drinking: Good and Bad

Dismay over Massachusetts' no-liquor-under-20 law enacted seven months ago has given way to optimism on the campus. The governor's pledge of strict enforcement seems to have been directed mostly toward high school students — and perhaps to have been motivated as much by politics as by public safety. Neither city nor campus police have actively sought violations.

Student party planners are finding that the new drinking law "frees up a lot of money once spent on booze," notes Steven Solnick, '81, in *The Tech*. But Richard G. Larkin, '83, reports a disadvantage: social segregation. "Because the law inhibits casual visits to a bar or night place by a group of under- and upper-classmen together, social patterns of association have probably changed slightly.

"The old interaction between students of all ages," writes Mr. Larkin, "seems to be missed more than anything else."



From identical kits of assorted scrap materials, students fashion ingenious entries in yet another Subject 2.70, Introduction to Design course for Mechanical Engineering majors (and a large enrollment from outside the department.)

This year's problem was to design and construct a device that would travel from the center line of a long pivoted horizontal aluminum beam and attempt to tip the beam downward while an opponent device tried to do likewise on the other side of the pivot. "The power for the motors came from the contact strips on the beam," explains Eric Sklar in The Tech. *"In terms of function, the machines classified themselves into several groups: those that didn't move, those that moved but didn't stop at the end of the beam, those that moved in the wrong direction, and lastly, those that moved in the right direction and stopped before the end of the beam," he writes. One device resembled a DC-10 and shortly after it started an engine dropped off and dangled by a string.*

Jamming Room 26-100, the audience voiced enthusiasm that was at times ear-splitting, always exuberant.

Photos: James J. Snyder, Courtesy Technique; *top right, Calvin Campbell*

A Cycle of Bassoonists?

I would have greatly enjoyed "M.I.T. Night at the Pops" last June 7 with John W. Miller, (VI) '64, as bassoon soloist *(Aug./Sept., pp. A1, A9).* I played principal-chair bassoon in many of Arthur Fiedler's orchestras and groups in and around Boston. He brought me to audition before Stowkowski, and one year I won the northeastern states contest. Sometimes Fiedler would pick me up in his Ford convertible at the Institute on the way to our concert, and I'd get an earful of his sharp, witty comments on M.I.T. and the Boston scene. Noting the progression from X'39 to VI'64, I propose that there will be an outstanding bassoonist in II'89 — and a JWM at that!

J. W. Mohlman, (X) '39, South Laguna, CA.

Caging Cambridge Non-Profit Monster

Under a special act of the Massachusetts legislature last fall, Cambridge now has the power to control the expansion of tax-exempt institutions within residential areas. The idea is to "protect the residential character of the city's neighborhoods," said Mary Ellen Preusser of the Cambridge City Council. "Before this, the tax-exempt institutions were like a monster gobbling up Cambridge. Now we've caged the monster," she told the *Boston Globe.*

Walter L. Milne, special assistant to the president at M.I.T., told the *Globe* he understood the problem but didn't think the Institute was a factor in the new law or in jeopardy because of it.

Radioactivity Emergency in Cambridge?

The fall-out from Governor Dixy Lee Ray's closing of the radioactive waste disposal site in Hanford, Wash., last October continues to hover over Cambridge, Mass. So far it has been benign, but political overtones make it more than a little worrisome.

The Hanford site received and processed low-level liquid wastes from M.I.T. and many other New England institutions. With it closed because of Governor Ray's misgivings about alleged careless shipping and packaging practices, M.I.T. is holding its low-level wastes in its approved (by the Cambridge Fire Department) storage facility on Albany St. where they've normally been accumulated prior to each quarterly shipment to Hanford. Robert A. Alberty, dean of the School of Science, says the Institute could go until spring before needing to make a shipment — and "arrangements could be made to accommodate such wastes for several months beyond that."

Murray Bolton, M.I.T.'s radiation protection officer, told *Chronicle of Higher Education* that M.I.T. shipped 100 barrels of waste to Hanford just before the dump was closed. He said the institute normally ships once every three months and has enough storage space now to last about that long.

He expressed frustration with the rules governing disposal of materials with only low levels of radioactivity.

"You can walk into a second-hand store and buy a clock with a fluorescent dial emitting more radiation than is in some of the wastes we can't dispose of," he said.

"We're talking about very low levels of radioactivity," he said. "The sad part is, people are trying to equate this with nuclear power generation."

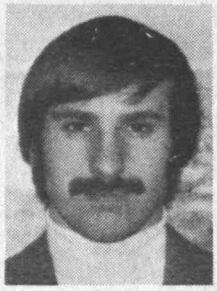
Meanwhile, presumably inspired by Governor Ray's action and perhaps resonating to increased public interest following the Three-Mile-Island accident, the Cambridge City Council opened some questions in November: How is radioactive waste generated in the city; how is it handled, stored, and disposed of; and how will the emergency closing of the Hanford (and other) dumps affect public safety? After holding preliminary hearings, the Council ordered a formal inquiry, now in progress.

No one ventures to predict the outcome, since to many observers the issue seems more related to political than physical health in the city. But Dean Alberty and other M.I.T. officials have pledged full cooperation, and Dean Alberty told the Boston-area press in November that "M.I.T. has over a period of many years enjoyed a virtually spotless record in the handling and transporting of these materials. The Institute has even been cited as an example for others to follow," he said.

If you'd come home for Homecoming . . . In addition to football (see pages A17-19), you'd have seen a marching band with its own T-shirts; Leo P. Harten, '77, perennial winner of the "ugliest-man-on-campus" contest, leading a band of Roman revelers from Pi Lambda Phi; and other assorted expressions of campus spirit. (Photos: James J. Snyder, '80, courtesy Technique, *and Mark H. Sloan, '81)*

The Other Side
John Molitoris

The Wonder of Science



John Molitoris, '80, studies physics at M.I.T., where he is a member of the Heavy Ion Research Group. Though he enjoys writing about the philosophical and humanistic aspects of modern science, until now John has written mainly for himself and for The Tech.

To see the world in a grain of sand,
And a heaven in a wild flower,
Hold infinity in the palm of your hand,
And eternity in an hour.

from Auguries of Innocence
by William Blake

I guess it was last spring when I was at home watching my nephew explore our back yard. Glenn is a fine boy; at that time he was a little over two years old. Children at that age are fun to watch and Glenn was no exception. He would notice something moving on the sidewalk, lean over to get a closer look at it, then point at it and say "Bug-Bug." When Glenn felt he had studied something enough, he would just wander off and find something else. Everything important, everything interesting, it was just that there was so much of it that he could not decide how to divide his time. This wonder that children exhibit when they encounter the world around them is truly unique. The child is trying to learn so much from what he observes, from what his curiosity leads him to examine.

All of us have this wide-eyed outlook at the beginning of our lives. It is essential for us to grasp our surroundings and to gain the understanding it takes to get along in the world. What is quite sad is that as we grow up we tend to lose this awe of the world. The wonder is replaced by apathy. Even when an adult strives to learn, his inquiry might be biased by the things he knows. The fresh outlook is lost.

Or is it?

The motivation for any inquiry, be it the search for quarks or a fountain of youth, stems from the same curiosity that we experienced as children — the curiosity that enables us to seek principles which govern the new and strange, and to extend the existing science to the farthest reaches of space.

Confrontations with Cross-Bearers

As a physics major at M.I.T. I have had the opportunity to do research in my field (nuclear, well actually it's called heavy-ion physics if I want to be technical about it!). This has brought me into contact with quite a few excellent people in science. I have always been impressed by the enthusiasm of the scientist for his work. You cannot help but get excited about it; in fact, if you didn't it would be very difficult to do science. Many people who are not in science don't understand this. They see boring equations and perhaps rote memorization, which is far from the reality.

The attitude that science draws one away from culture and the humanities also exists. I really can't say where I first heard this, but after the first time, I heard it again and again. You don't hear it until you admit that you are studying engineering or science, and the person who tells you is a liberal arts major, or usually some professional in the liberal arts. "It" (in case you've been wondering) is a line that goes something like, "Yes, without the artists, the poets, the writers, who I ask would humanize the scientist and engineer?" It is not really that bad (because if you hear it at a party you can just walk away), but sometimes this person is a friend or a professor. Then you are in a jam (because they seriously intend to humanize you!). You could break their hearts and tell them that you are already human, but of course they won't believe this. However, if you keep insisting they might let up. This situation is interesting. It is interesting because you are being insulted, although the insulter does not realize it. In fact there is quite a bit this self-appointed cross-bearer does not realize.

A Very Special Awareness

The scientist and engineer deal with nature; their world is the real world and perhaps a little more. It is a world of such stark reality that one has to marvel at it. When they do talk about it, it is in their own language, a language noted for brevity and exactness. There is a distinct beauty in this language which is often lost upon translation to layman's terms. The primary beauty, though, is that nature is there and that we can find out about her through our curiosity, just as we did so many years ago.

The Awe and Beauty — and Its Expression

I have been concentrating on the scientist, but in fact people in all walks of life are able to keep open the channel to that child-like state of wonder and use it for creative ends (it's just that science demands curiosity in the scientist). In this sense, creativity itself becomes a human resource which we all draw upon to understand and build the world. People use their creativity in a multitude of ways. The artist's inquiry leads to expression through the work. What feature can the artist bring out to make people feel something? The concert, the dance, the painting and sculpture — they all reach out and touch you, whereas science merely beckons. Or perhaps it is the different natures of art and science that come into play? Shakespeare said that a rose by any other name would smell as sweet. I wonder if he ever considered how sweet the fragrance would be without a name?

I believe that this is where the purpose of the humanities lies — in the expression. The scientist has the ideas; but they are locked up in his mind, in mathematical symbols and technical jargon. The awe and beauty are there; it's just that the art that is science is so subtle, its purpose in understanding.

The back yard that the scientist explores is a little bigger, and the time he spends with each flower is a little longer, but in essence the situation and the attitude is the same. That is, seeing so much in so little and realizing what it is worth, ". . . the world in a grain of sand."

Carl Richard Soderberg, 1895-1979: Gifted Teacher, Dynamic Leader, Towering Figure

Carl Richard Soderberg, '20, who was distinguished as a mechanical engineer for contributions to turbine design and as a teacher for building what many regarded as "the world's leading mechanical engineering department" at M.I.T., died of cancer on October 17 in Cambridge. He had been a member of the faculty since 1938, head of the Department of Mechanical Engineering from 1947 to 1954, dean of the School of Engineering from 1954 to 1959, and Institute Professor in 1959-60.

And beyond all the statistics of his professional achievements, he had been a warm, unassuming friend to many colleagues throughout the M.I.T. community and the profession he served.

Julius A. Stratton, '24, president emeritus who was chancellor during Professor Soderberg's term as dean of engineering, described Professor Soderberg as "a towering figure in the history of this institution.

"For over 40 years (he) was a distinguished presence on our campus — a man of broad culture and learning, exceedingly wise, thoughtful, and with a deep understanding of the needs and the process of education. . . . He will long be remembered with special warmth by the students he taught and the faculty he nurtured."

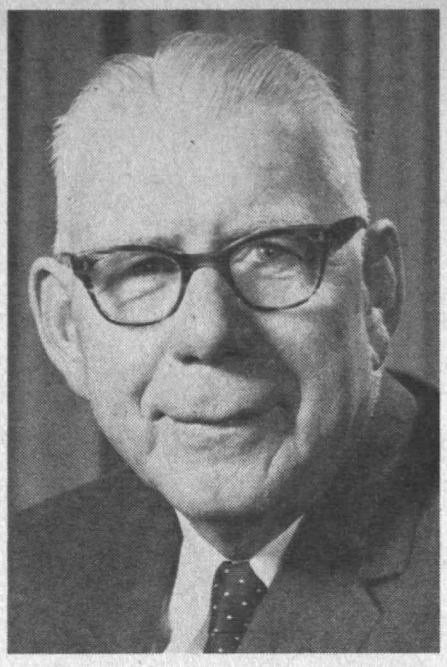
Dr. Soderberg, born in Sweden, came to the U.S. in 1919 on a fellowship of the Scandinavian-American Foundation following graduation from Chalmers Institute of Technology; a year later, after study at M.I.T. and the University of Michigan, he received the S.B. from the Institute in naval architecture and marine engineering.

Then came several years of industrial work in the U.S. and Sweden — notably as chief turbine engineer for Westinghouse Electric Corp. during the period when high-pressure, high-temperature turbines for power and propulsion were first introduced. Even after he returned to M.I.T. to join the faculty in 1938, Professor Soderberg continued his leadership in this field through research and consulting; he was a key figure in the development of the Pratt and Whitney J-57 engine, a milestone that revolutionized air travel.

Dr. Soderberg was honored by his first *alma mater* in 1951 with the honorary degree of doctor of technology; and by M.I.T. in 1975 by establishment of the Carl Richard Soderberg Professorship of Power Engineering. He held the John Ericsson Gold Medal of the American Society of Swedish Engineers (1952), the Knight of the Order of the North Star (1958) from the King of Sweden, and other prizes and citations.

George Warren Smith, 1905-1979

George Warren Smith, '26, whose many services to M.I.T. — including over 30 years as class secretary — earned him the Bronze Beaver Award in 1964, died in Gloucester, Mass., on October 15. He was 74.



Mourning the death of Professor Carl R. Soderberg, President Jerome B. Wiesner said he was "a dynamic leader in engineering education who had a truly remarkable rapport with young engineers and with students in the classroom. He was able to transfer to another generation not only his technical know-how but also his clear understanding of the nature of the engineering profession and its responsibilities to society."

James R. Killian, Jr., '26, former president and honorary chairman of M.I.T., spoke for all his classmates in a tribute which appears in full elsewhere in this issue of the *Review:* "For all his good works, and for the quality of his personality and character, those privileged to know George Smith will always cherish his friendship and find in it a benediction."

At the time of his retirement in 1964, Mr. Smith was district sales manager for E. I. du Pont de Nemours and Co., Inc., in Boston; since then he had been active in a small business of his own and in retirement activities centered on the sea and shore of Cape Ann. His enthusiasm for sailing led him to head an aggressive and successful campaign for funds to refurbish the M.I.T. Sailing Pavilion in 1975; earlier he had been a member of the Alumni Association's Executive Committee (1950-52) and of the Alumni Fund Board (1948-54), of which he was chairman in 1953-54.

But George Warren Smith's most faithful service was as secretary of his class, writing regular and widely appreciated contributions to *Technology Review* and creating what Dr. Killian calls "an interactive fellowship that gave a special character and friendly coherence to his class. In this fabric of our fellowship which he did so much to create," writes Dr. Killian, "he leaves a gaping hole."

S. W. Widnall

S. A. Coons

Professor Shiela Widnall: First Woman Chairman of the Faculty

Shiela W. Widnall, '61, Professor of Aeronautics and Astronautics, will be chairman of the faculty during the 1979–80 academic year — the first woman ever to be elected to this influential post.

As faculty chairman, she will head the Committee on Educational Policy, the group through which are channeled all proposals for curricular change and studies of educational programs. And she will be *ex-officio* a member of the Academic Council, the highest policy-making administrative group; the Faculty Council; and the Corporation Joint Advisory Committee on Institute-Wide Affairs. And, in the absence of the president of the Institute, she will chair the monthly meetings of the faculty itself.

Professor Widnall has been a member of the faculty since 1964, when she received her Sc.D. degree in the department in which she now teaches. Her major teaching and research are in the fields of fluid mechanics and elasticity, but she also takes part each year in the department's "unified" engineering program — an introduction for first-year students to the concepts, principles, and methods of engineering which are pertinent to all engineering fields.

Dr. Widnall is well respected in her profession. She holds the 1972 Lawrence Sperry Award of the American Institute of Aeronautics and Astronautics, and in 1974 she received the Society of Women Engineers' Outstanding Achievement Award.

Steven Anson Coons, 1912-1979

Steven Anson Coons, '36, who taught in the Graphics Division and Mechanical Engineering Department with distinction from 1948 to 1966, died on August 19 at Boulder, Colo.; he was 67.

Professor Robert W. Mann, '30, a close colleague, described Professor Coons as "an endearing, modest, gentle man of great imagination and inquisitiveness who was loved by all who knew him but especially by his students, faculty colleagues, and industrial collaborators."

Professor Coons joined the M.I.T. faculty in 1948 after 12 years of service to Chance Vought Aircraft Corp., where he developed mathematical methods used in defining and computing aircraft shapes; those methods later became the basis of computer programs used throughout the aircraft industry. At M.I.T., as a member of the Graphics Division and later of the Mechanical Engineering Department, Professor Coons made significant early contributions in the field of computer-aided design and in graphic interaction between computer and human; and he restructured the traditional drawing courses by stressing the broad applicability and power of graphics throughout science and engineering.

After leaving M.I.T. in 1966, Professor Coons held faculty positions at the Universities of Syracuse and of Colorado, and he had for several years conducted research in computer science in Budapest under sponsorship of the Hungarian Academy of Science.

John W. Hafstrom, 1943-1979

John W. Hafstrom, '65, who was a member of the faculty in the field of materials science and engineering in 1969-70 following completion of his Ph.D. in 1969, died on June 13; he was 36.

Dr. Hafstrom is remembered in Cambridge for important research contributions on materials structures and for extraordinary teaching, which was recognized in 1969 by the award of the Goodwin Medal. He had joined Raytheon Co.'s Missile Systems Division upon leaving M.I.T. and in 1975 joined the staff of Argonne National Laboratory to work on superconductive materials development. His recent research had been on magnetohydrodynamics and nuclear waste management.

Edward S. Lamar, 1906-1979

Edward S. Lamar, a member of the faculty in the Department of Physics from 1936 to 1941, died in Washington, D.C., during the summer. He was 73.

Dr. Lamar came to M.I.T. in 1930 from Princeton University to be a research associate under Karl Taylor Compton, who in the same year moved from Princeton to Cambridge to become president of M.I.T. After five years on the faculty, starting in 1936, Professor Lamar became a scientific consultant to the Navy Department; and he remained with the Navy Department as a civilian employee for the rest of his career, serving successively as chief scientist in the Bureau of Ordnance, the Naval Weapons Command, and the Naval Air Systems Command. He received the Navy's Superior Civilian Service Award upon retirement in 1975.

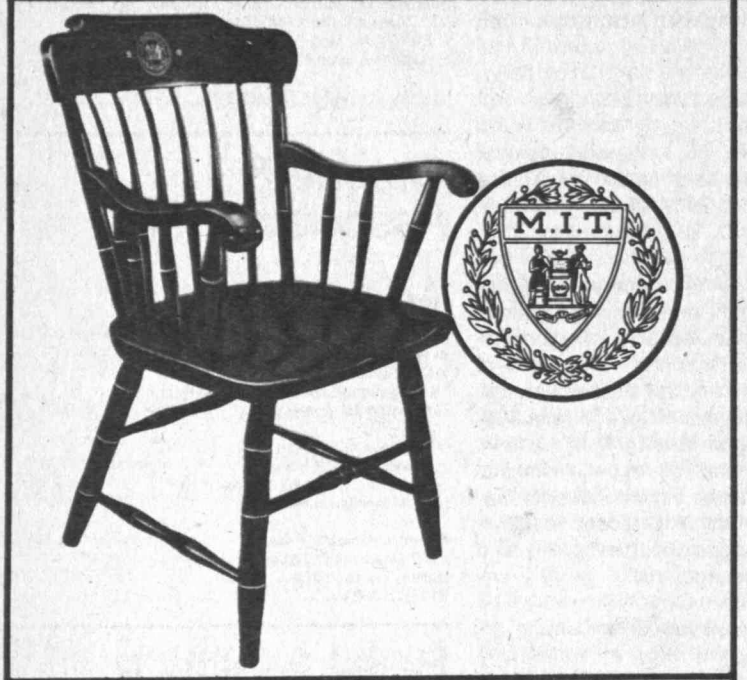
Eugene Mirabelli, 1898-1979

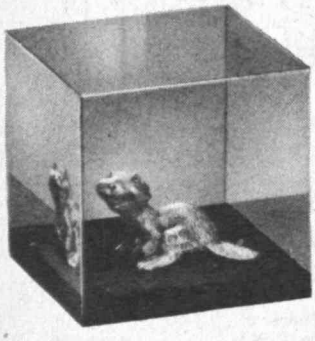
Eugene Mirabelli, '19, whose teaching career at M.I.T. spanned half a century and influenced thousands of civil engineers, died in Lexington, Mass., on October 5. He was 81.

Professor Mirabelli was an authority on structural design and analysis in steel, reinforced concrete, and wood. But even more he is remembered by his colleagues and students as an excellent teacher and a man of great personal dignity.

M.I.T. INSIGNIA

A GOOD WAY TO REMEMBER





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03

Our Harvest Time is not confined to our verdant pastures of southern Kentucky for our welcome class news brings forth abundant good cheer to our present classmates.

Your class secretary, active at 98 years of age, still adheres to plain diet and nightly slumber; so loyal classmates of mature '03, we should follow the Golden Rule, "We live to live daily." We thus can lead the alumni news of the Review and cheer entering members of the list for their future success.

Our birthday greetings to our loyal classmate, **Jay B. Simon**, October 29, 1879, 33,300 Uticee Rd., Fraser, Mich. — **John J. A. Nolan**, Secretary, 417 Dorsey Way, Anchorage, KY 40223

12

Henry M. Foley, from Birmingham, Mich., at 90 enjoys contract bridge two days a week at the Senior Men's Club of Birmingham. He has four sons, fifteen grandchildren and two great-grandsons.

John W. Connolly writes from Ponte Vedra Beach, Fla., that all is well with him. . . . **Albert Harkness** closed his office in Providence, R.I. in 1974, and has been getting 60 years of records into shape and returning original drawings to owners. He writes that his health is fine except for a little stiffness in the joints.

Don Radford is living in Duluth, Minn., as he has since 1910. He still drives and gets around but is living alone since his wife's death on July 26, 1979. He speaks of **Jon Noyes** and family, who lived in Duluth for a number of years. Don retired late in 1956 from a family business manufacturing millwork and related lines.

Woody Woodward broke his leg (a femur) last January and now uses a cane or a walker. He has been staying this past summer with his daughter Dorothy at 905 Country Club Dr., Greenville, Pa. His health is good except for the leg. He sends best regards to 1912 class members.

Paul Tyler, writing from Bradenton, Fla., was good enough to send a very legible card in spite of complaining about his arteries which have slowed him down and kept him from walking and swimming. He worried that I could not read his writing. He has taken to reading fiction, on the advice of his wife and the local librarian, which has helped him to keep occupied.

Bernard Stevens' wife Emily writes that he has just had his ninetieth birthday, and that while he is in pretty good health, deafness and blindness have slowed him after an active life.

I regret to have to report the deaths of **John W. Raymond, Jr.** of Princeton Ave., Beverly, Mass., at age eighty-nine, and of **Seth H. Seelye** of Springwood Dr., Spartanburg, S.C., on September 6, 1978, at age 86. — **Phil Dalrymple**, Secretary, 59 Boulder Rd., Wellesley Hills, MA 02181

13

My plea for news has born fruit. We have several interesting notes and hope for more.

Burton L. Cushing writes: "I am retired from active work but do some real estate work. My wife died 13 years ago, but I still live in the house we bought in 1937. I have a good housekeeper. I attend Kiwanis regularly each Thursday and the Rockland Chamber of Commerce once a month. I have been a member of the C. of C. since 1914 and was made an honorary member in 1975. I have been an active member of the Rockland Congregational Church since 1910. I taught in the Sunday School for 30 years, 10 of which I was superintendent."

We have not heard from **Robert Schulze** for some time, so we were glad to receive a letter from him. He writes that he has cataracts in both eyes and has to use a magnifying glass. His doctor has told him he can no longer live alone, so he has a niece living with him. He wonders "how she likes or can stand her old uncle." Robert's wife died a year ago, but they had a very happy married life for 63 years. He also says: "So nice of you to carry on and I will never forget the pleasant rides on the train with your husband during our college days, getting off at Readville for home."

From **David Stern**: "Acceding to your request for family news, Della and I acquired our seventh great-grandson, Adam Charles, on June 17! As for Della and me, we have both endured ill health for two years. Della has had two heart attacks. Happily, she has staged a good recovery. I started out in March 1977 with what the doctor named 'polymyalgea rheumatica' and am now in the sixth month of recovering from a 'ruptured aorta.' Which ain't easy at 88 years." Congratulations on your great-grandson, Dave.

J. W. Brooks Ladd writes: "Still going strong at 90. Possibly not as active as before, but I swim in the Dorset House pool almost every day and drive about 5,000 miles a year in my 65 Cadi, mileage 96,000. I take three trips a year to see friends and relatives in Danbury, Conn., Newark, Ohio, Eugene, Ore., and Pasadena, Calif. It's a good life."

Mrs. Wood advises that **Charles Wood** is living in a nursing home.

We are indebted to David M. McFarland, '18 for the following notice of the death of **Donald V. L. Downs**. "Donald Van Lear Downs, 89, who spent much of his life restoring the Delaware home that had been in his family for more than 200 years, died September 26 after a brief illness in Kent General Hospital in Dover. Mr. Downs also maintained a home at 1928 Delancey Place in Philadelphia. In 1971, the U.S. Interior Department designated the Delaware homestead, known as Aspendale for the aspen trees planted there, as a national historic landmark. The plaque noted that 'this site possesses exceptional value in commemorating and illustrating the history of the United States.' The Georgian-style plantation house, located in Downs Chapel near Dover, is built of bricks made from a nearby clay-hole. During the Revolutionary War, pieces of its metal roof were melted to make bullets.

Mr. Downs, a bachelor, traveled extensively, collecting antiques with which to furnish Aspendale. His restoration efforts won him an award from the Friends of Old Dover. He was born in Dover, attended Mercersburg Academy, and graduated from Lafayette College. He also received an engineering degree from M.I.T. in 1913. During his early career, he worked as a consulting engineer. Later, he helped form Downs-Furness Company of Media, Pa., which engages in the restoration of old homes in the Delaware County area. He also was an active member of the board of the Octavia Hill Association, which restored a home he had once owned in Society Hill."

This is all for now. More news next month. — **Rosalind R. Capen**, Assistant Secretary, Granite Point Rd., Biddeford, ME 04005

14

Dorothy Affel recently sent me a copy of the third-quarter, 1979, report of American Telephone and Telegraph. In it is an article about the Bell Laboratories' observance of the 50th anniversary of the invention of the coaxial cable, which "dramatically increased the calling capacity of the long distance network." The article mentions that **Herman Affel**, who was Class Secretary from 1964 until failing health compelled him to resign about a year before his death in 1972, was one of the co-inventors of the coaxial cable. During his long and distinguished career at the Bell Laboratories, Herman was the inventor or co-inventor named in 123 patents, but I don't remember that he ever said a word about that or any others of his outstanding accomplishments in telephony. — **Charles H. Chatfield**, Secretary, 177 Steele Rd., West Hartford, CT 06119

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M.I.T. has lost an outstanding alumnus and we have lost a fine classmate and friend. **Phil Alger** died in Schenectady, N.Y. on September 24. He had been ill for a long time and had been here in the Massachusetts General Hospital several times, where classmates had visited him. Phil was a very loyal classmate, having attended every class reunion, and he always made me a personal visit whenever he was at M.I.T. He boasted of his three-generation family who had attended M.I.T. His son, John, was class of 1949, and his grandson, Monty, was class of 1977.

Phil was active in many trade and scientific associations. He contributed much to the development of the induction motor and was very active at General Electric Co. in Schenectady. He had published many papers and books on his work. In addition, he had written several books on his family and their history — he was really an outstanding man. He was extremely popular in our class and we'll all miss him. I phoned his son

and family in Schenectady with condolences from our class.

Alton Cook had a little trouble with a sore arm but since I have not had any of his humorous letters recently, I presume and hope he's in good health again. I see or keep in touch with the classmates who are living locally: **Wayne Bradley, Dinger Doane, Clive Lacy, Horatio Lamson, Larry Landers, Wally Pike**, and **Bob Warren**. For our age group we are all in fairly good health, but our mortality rate is high. **Jim Tobey** writes his usual humorous letters.

Harold C. Edgerton died August 22, 1979 in Venice, Fla. He had been an active member of the Lake Venice Golf Club.

All the best to you all and your families for a happy holiday season. — **A. W. Mack**, Secretary, 7 Atwood St., Wellesley, MA 02181

16

There were several responses to invitations for our November 14 luncheon at the M.I.T. Historical Collections Center: **Don Webster** — "I wish I could join you at the Historical Collections Center on Nov. 14, but probably I won't be able to. My bad back trouble has left me with limited mobility since last year and this makes getting around in public places difficult." . . . **Joel Connolly** — "Thank you for the invitation to the Nov. 14 lunch. I am sorry I am unable to accept, much as I would like to join with you and our other classmates." . . . **"Cy" Guething** — "Thanks for the notice of your meeting — sorry but can't make it. You classmates living in the East have many advantages, and one of them is the reunions and get togethers. I wish I could see you more often. My best wishes to you all and keep breathing." . . . **"Shats" Ober** — "Please enjoy the 1916 visit to M.I.T. Historical Collections. I do not expect to come."

These notes are being written three weeks prior to the luncheon so we can't know who will attend. We're hopeful that classmates in the Boston area will show up. We did have a call from **Hy Ullian** that he and Frieda will attend.

We've also talked with **Dan Comiskey** and he hoped to attend, but Grace fractured her arm and this may make it impossible for Dan and Grace to attend. Dan talked with **Nat Warshaw** and he definitely planned to attend. . . . Talked with **Anne Richmond** and she and Izzy planned to attend. . . . **Barney Gordon** told us that he hoped to attend. . . . **Henry Shepard** wasn't feeling too well and didn't know whether he and Frances would attend. **Francis Stern** was not going to be able to make the trip from Hartford. **Earle Pearson** wrote that he couldn't make it. **Fred Upton** wrote: "Keeping track of thirteen granchildren, scattered from Maine to California. Some are starting new families in distant places so life goes on."

We regret to report the deaths of **Fred Spencer** of Burlington, Vermont, and **Bill Boyd** from Hendenson, N.C.

Keep the letters coming and "Keep Breathing" and "Keep Walking." — **Ralph A. Fletcher**, Acting Secretary, P.O. Box 71, West Chelmsford, MA 01863

17

A note from some anonymous friend said he drove into Cambridge on an early fall Sunday afternoon along Memorial Drive. He counted 100 sailboats in the Charles River Basin in front of the Institute stemming mostly from the M.I.T. **Walter C. Wood**, Sailing Pavilion. With the sun shining on the sails, it was a glamorous sight. His hat was off to Jack Wood for starting it all. A note from **Larry Clayton** regrets he cannot look forward to coming to the 62nd Reunion. He is not too mobile any more. Our best regards to Larry and we will miss him at the Reunion. He lives now in Jacksonville, Fla., and at least will keep warm this winter.

A recent letter from **Stanley Chisholm** chides us for omitting news of many classmates who are still extant. So let this be a lesson to those who do not respond to various communications from the Alumni Office and Class Officers. Stanley also noted that no 1917 class notes appeared in the Aug./Sept. issue of the Review. The only apology I can make is that there was some breakdown in communications between me and the Alumni Office.

A few words from **John De Bell**. His mail address is East Longmeadow, Mass. but his telephone number is Crescent Lake, Conn. However, John has convinced Massachusetts authorities that this dichotomy has no tax implications. He reports his health is good; he drives his car, gardens, and saws wood with a rest every five minutes. Being John De Bell, he keeps busy. He is a trustee of the local hospital and helped the town engineer to locate a bridge. His wife, Emma, recovered from an attack of tuberculosis two years ago because of up-to-date medical care. Their daughter lives nearby and so does their son, Richard, who is an expert in the field of "product liability." John was prevented by his own infirmities to hear his son present a paper on "Product Liability." He sends his best wishes to all of the Class.

Al Lunn returned from Cape Cod to his home in Cambridge. **Stan Dunning** sees him often. Al is still being cared for but he is now at home. We regret to report the death of **Luther M. Lauer** of Orchard Park, N.Y., on July 23, 1979. Luther was a chemical engineer and worked at various times for Merrimac Chemical, DuPont, and Aniline Chemical and Dye Corp.

In September, Katherine and **Ray Stevens** celebrated their 59th wedding anniversary and in October, Doris and **Bill Hunter** had their 55th wedding anniversary. In September, the Hunters visited their eldest grandson who is a freshman at Cornell University. It was parents and grandparents weekend for the freshmen. It was a glorious weekend with a beautiful concert at the large Bailey Auditorium there and with many nice tours and a church service on Sunday. In October the Hunters went out to Wisconsin to the other grandson's school, St. John's Military Academy, as he was one of two boys appointed Captain. He requested that Bill, his grandfather, whose namesake he is, to come out and present him with his sword at a ceremony immediately following morning services in the beautiful chapel at the school. After lunch, the whole school gave a full dress parade which was indeed spectacular.

On October 16, 17, and 18th, the 62nd reunion was held at the SheratonBoxborough, Mass. Inn. Most of the reunioners arrived on the afternoon of the 16th. The first activity was a cocktail party followed by dinner. The following were present: Christine and **Walter Beadle**, Jeannette and **Stan Dunning**, Pat and **Bob Erb**, **Al Ferretti**, Sally and **John Holton**, Doris and **Bill Hunter**, Mildred and **Stan Lane**, Laura and **Frank Peacock**, Alice and **Bill Neuberg**, **Ed Payne** (Elizabeth could not be with us as she was just recovering from an illness), **Jesse Rogers**, **Clarence Seely**, and honary members Jay Stratton, and Don and Phylis Severance. Out of a class of 109 active members, we had reply cards from over half of them. There are 30 classmates for whom we have no addresses so we do not know their present status. The Butterworths had intended to come to the reunion but **Frank Butterworth** was in the hospital, all rather suddenly. Also, **Ray Stevens** had intended to come but Katherine was in the hospital and he was reluctant to leave her. **Henry Strout** sent word that Ruby was in the hospital with a broken hip. We extend our sympathy to them all and wish them a speedy recovery.

Sally and **John Holton** had been celebrating their 60th wedding anniversary for a week, with many parties, one of which their children, from far and near, attended. To add to the festivity of the reunion banquet on Wednesday evening, the children and grandchildren of the Hunters sent wine for all assembled to honor their parents on their 55th anniversary.

On the 17th, we were invited by Ken Olsen, president of Digital Equipment Corp., an alumnus of the M.I.T. Class of 1950, for luncheon. Ken gave us a most interesting talk on the founding of the company to manufacture computers and component parts. He and the other founders of the company gained their expertise in laboratories at M.I.T. After a delicious luncheon, he told us that since organizing the company, their aim had been to produce computers and components of quality and to reduce their size and power requirements. In this they have been eminently successful; witness the sales growth from $135 million in 1970 to $1,804 million in 1978.

At our annual meeting it was authorized that a letter of congratulation be sent to the president-elect of M.I.T., Dr. Paul Gray, with our best wishes and offer to assist him in any way which we might be of use to him. It was discussed and approved that we no longer continue annual interim reunions, but rather, just celebrate the five-year ones. It was also agreed that whenever a group of the class wished to get together during any year they should do so, particularly at the Institute. It was suggested also that a class luncheon or dinner might occur during the Technology Day in June. Jay Stratton gave us a good talk on the process of selecting a new president. The committee certainly deserves a great deal of credit for this awesome task.

Another subject that was brought up at the meeting was about the funds of the class. They are as follows:

Aldrin Fund	$105,000.00
1917 Memorial Fund	100,000,00
1917 Special Project Fund	85,000.00
Total	$290,000.00

It was voted that $15,000 from the 1917 Special Project Fund be given to Historical Collections to arrange an exhibit on the wall approaching the Alumni Headquarters and the Margaret Compton Gallery, leading from the rotunda of Building 10. It was also voted that, after the Historical Collections deduction, the 1917 Special Project Fund be discontinued and liquidated by transferring its funds to the 1917 Memorial Fund. In consequence, undesignated gifts to the Alumni Fund henceforth will be applied to the 1917 Memorial Fund. Another vote directed that the income from our 1917 Memorial Fund is to be used for undergraduate scholarships.

Since these notes were submitted, we learned of the death of Katherine Stevens on October 19. The sympathy of all of the Class is extended to Ray. — **W. B. Hunter**, Secretary, 711 Farmington Ave., Apt. B-9, West Hartford, CT 06117

18

Among the activities taking place at M.I.T. is the Alumni Seminar Series, now in its fourth successful year. This group of M.I.T. alumni and their better halves meet for dinner once a month at the M.I.T. Faculty Club followed by a talk by an M.I.T. professor on economic or social problems of the day. Your secretary has been involved in this activity, which has grown from forty to over eighty participants from the class of 1918 to the class of 1979. This year's theme is "Capitalism: An Endangered Species." The October speaker, Dr. Carl Kaysen of the Humanities Department, noted that most of the world — Africa, Asia, and Latin America — does not even have capitalism problems yet. As for the Western world, he believes it will make the necessary accommodations to solve its many problems.

Most faithful correspondent **Herb Larner** is responsible for this most heartwarming and affectionate memory of Dot and **Clarence Fuller**: "Your notice of **Clarence Fuller**'s death brings to mind fond memories of our many happy get-togethers with him and Dot. They were among my oldest and best friends. When my wife Lillian and I came to this part of the country in 1920 we lived in East Orange for five years, where the Fullers had a house. Lillian and Dot Fuller became great friends. The **Pete Harrals**, and the **Herbert Jermains**, the **Jack Kennards**, the **Ned Longleys**, and others whose names and indentities I have forgotten also lived in this area. My office in New York was in the old Hudson Terminal Building now gone and replaced by the World Trade Center. So Clarence and I saw a lot of each other and cooperated a bit in business. Eventually he moved back to Foxboro and I built a house in Glen Ridge, and our contacts became much less frequent.

Dot and Clarence had two nice children, David and Jane, and here is the point of my story. On Thanksgiving morning in 1945 I answered the doorbell in my home in Glen Ridge to find Dot and Clarence standing there. They had changed a lot, especially Dot. Her hair was snow white. Clarence told me privately that it had changed practically overnight. During the course of their visit we inquired about the children and without a trace of emotion in her voice, Dot told us that David had been reported "missing in action" the day before the end of the war with Japan. He was a flier, you know. She told the story as calmly as I am typing this letter, and I never admired anyone in my whole life more than I did that woman on that Thanksgiving morning. The last time we saw Dot and Clarence was at the Wianno Club in Cambridge at our 50th reunion.

Well I had to get this story off my chest to someone and you were elected to hear it. How sad it is to read the obituaries in each issue of the *Review*, but that's life, and passing on to the next world is just as natural as being born into this one."

I regret to report the death of **Lawrence H. Flett**, a research chemist and for many years the director of the New Products Division of the Allied Chemical Corporation, on June 25, 1979, in New London, N.H. Mr. Flett, who formerly lived in Scarsdale, N.Y., was 83 years old. He was born in Melrose, Mass. He received a bachelor's degree in chemistry from M.I.T. Mike worked for the National Aniline Division of Allied Chemical for 37 years. After his retirement in 1955, he served as vice president and president of the Chemical Marketing Research Association. He is survived by two daughters, Ruth F. Joachim of Bethelhem, N.H., and Sally J. Nygren of Fagersta, Sweden; a brother, Louis of Lanesville, Mass.; a sister, F. Telma Cummings of Barnstable, Mass.; eight grandchildren; and one great-grandchild. — **Max Seltzer**, Secretary, 60 Longwood Ave., Brookline, MA 02146; **Leonard I. Levine**, Assistant Secretary, 519 Washington St., Brookline, MA 02146

20

Recently your secretary enjoyed a very pleasant get-together at the home of Bill Ryer, '54, who lives in Winchester. Bill's father and mother were there, also Pat and **Buzz Burroughs** so we had a fine time talking over old times. Must say that both Ed and Buzz belie their years. Buzz plays golf all summer and curls all winter to keep himself in excellent shape. More power to him and to Ed.

An illustrious member of our class died on Oct. 17. **Carl Richard Soderberg** of 11 Memorial Dr., Cambridge, was institute professor emeritus at M.I.T. He was internationally known for his pioneering work in the design and development of the turbine engine. Dick was dean of the School of Engineering for five years and headed the Department of Mechanical Engineering for seven years before that. For his achievements as designer and inventor of steam turbines and generators he was made a Commander of the Royal Order of the North Star by the Swedish government. He was accorded the exceptional service award of the U.S. Air Force, the certificate of appreciation of the Army and Navy, the Linnard Prize of the Society of Naval Architects, the Ericsson Gold Medal of the American Society of Swedish Engineers, the Gustav de Laval Medal and awards from the A.S.M.E. and its New England branch.

M.I.T. established a professorship in power engineering in his honor. He was the recipient of honorary degrees from Tufts University and the Chalmers Institute of Technology in Sweden, where he was awarded a doctor of technology degree, the first of its rank to be given by this distinguished technical institute.

After graduating in 1920 he worked for the New York Shipbuilding, Corp., then joined Westinghouse Electric Corp., in Pittsburgh. He then returned to his native land as a development engineer for the Swedish General Electric Co. Back in this country, he was made chief turbine engineer for Westinghouse until his appointment as professor of applied mechanics at M.I.T. in 1938. Dick was a fellow of the American Academy of Arts and Sciences, the American Society of Mechanical Engineers and the Institute of Aeronautical Services. A widower, he leaves two sons, a daughter and 13 grandchildren. A genial and kindly man with an ear-to-ear grin, he was truly a great credit to our class and will be sorely missed. — **Harold Bugbee**, Secretary, 21 Emerell Rd., Winchester, MA 01890

21

We have been notified of two deaths this past month: **Charles L. Pool** of Essex, Conn., on July 20, 1979, and **C. Doane Greene** of Rock Hall, Md., on October 6, 1979. **Charles Pool** earned degrees both at M.I.T. and at the Harvard School of Engineering and Public Health. As a sanitary engineer he worked for the states of Connecticut, New Hampshire and Rhode Island. He served as chief of the Institute of InterAmerican Affairs in La Paz, Bolivia, and was decorated by the Bolivian government. He also worked for the World Health Organization under the United Nations and represented the U.S. Navy on the National Research Council Committee on Sanitary Engineering.

Doane Greene was captain of the swimming team at M.I.T. and served in the Navy in World War I. During his business career, he was plant superintendent in Pittsburgh for Atlantic Refining, an engineer with M. W. Kellogg, and a chemical engineer with the Edgewood Arsenal in Maryland. In retirement he was an ardent yachtsman and won a number of races in his Columbia Sabre.

Gladys (Mrs. **Paul**) **Rutherford** recently made a generous gift to M.I.T. in Paul's memory. Like many wives of deceased classmates she continues her interest in M.I.T. and her close ties to the Class of 1921. We hope she will come to our 60th Reunion.

Betty and I recently had lunch with Dorothy (Mrs. **Joseph**) **Wenick** and were brought up to date on the family "doings." Dorothy is busy cleaning out her Caldwell house and will soon move into her permanent home in Florida. However, she expects to come north every summer like many of our classmates, so we expect to see her now and then. During luncheon Dorothy gave me a copy of the July, 1921, *Technology Review* which Joe bought long years ago. It was not a nationally known magazine in those days; its contents were completely about undergraduate and alumni affairs, and the size and form very different from today's magazine. But it was fascinating to read about our graduation and about our Class Day in Walker Memorial when the class put on a skit which was ostensibly a faculty meeting. Professors were gently caricatured, and it was said that Bursar Ford had lost the endowment funds at the race track, so M.I.T. was "broke." And so it went. If I get desperate for news some month, I could quote at length from the 1921 issue of *Technology Review*.

Two letters came in from **Grant Miner** during the last few weeks and both enclosed "yarns" he had written. The first was an amusing tale about his joining the Glee Club as an undergraduate at Carleon College even though (says he) his singing is terrible. The second was "The Story of Creeping Charley and Falling Stars" intended for reading aloud to children. So Grant is the second member of our class that I know of to write stories for children. The other was the deceased **Dana Kepner**. Grant's wife Marianne wrote music to accompany Creeping Charley and another story for children that Grant wrote recently. Now Grant says he is going back to school again, taking a course in 35 mm color photography. Such ambition!

Class vice president **Carole A. Clarke** writes that he and Maxine had a delightful three-week visit with their daughter Ellie and husband in Portland, Mich., on the Grand River. Cac fished (no luck), picked garden vegetables, and toured all over that part of Michigan. This included a visit to Michigan State College and an extensive craft show at Grande Ledge.

A phone call to Assistant Secretary **Josh Crosby** produced a few tid-bits of news. The Crosbys and the **Whittier Spauldings** spent the summer in Maine and stayed until early October before returning to Florida. Josh reports that his wife Claudia is just home following a successful cataract operation. . . . The **Herb Kaufmanns** are still as of October 20 at their summer cottage in North Carolina. . . . And finally I learned that **Larcom Randall** is up and around again, walking after leg surgery last spring. Cheers! Your secretaries wish you all the joys of the holiday season and good health in the New Year. — **Sumner Hayward**, Secretary, 224 Richards Rd., Ridgewood, NJ 07450; **Josiah D. Crosby**, Assistant Secretary, 3310 Sheffield Cir., Sarasota, FL 33579; **Samuel E. Lunden**, Assistant Secretary, 606 S. Olive St., #701, Los Angeles, CA 90014

22

There is good news in that Paul E. Gray will follow President Wiesner in leading M.I.T. to a greater future. Congratulations Paul and again thanks for the evening you spent with our class at the last reunion. . . . **Roy Stone** sends a beautiful Holland-American Cruise postcard of the S.S. Volendam cruising near Bermuda. Roy and Marion spent October traveling from Clearwater, Fla., to enjoy the pleasant drives and marvelous facilities of our sunny neighbor in the Atlantic. They were previously disappointed during their trip on the Doric when their itinerary was changed to miss Bermuda.

Milton Manshel has written from Naples, Italy, during a cruise on the M/S Sagafjord of the Norwegian-America Line. He left Florida on Sept. 18 for a 37-day cruise through the Mediterranean and returned October 25th. This cruise is through one of the most satisfying and history filled areas of the world.

An impressive ceremony was held at Windsor Locks, Conn., for the new C. H. Dexter headquarters and research facility, dedicating the building to **Fay H. Osborne**, their former technical director who invented the company's nonwovens process and numerous specialty materials — chief among them, tea bag paper. Fay was on hand for the dedication ceremony conducted by President Ralph H. Martin and Chairman David L. Coffin of the Dexter Corporation. Mr. Coffin noted that, although Fay retired in 1962, his presence is still felt as new technical breakthroughs and new materials continue to issue from their laboratories today. Their specialty papers and nonwovens are now marketed in 50 countries. The papers are still based on the "long fiber" process from Osborne. They also make the reinforcing base for sausage casings. The Fay Osborne Building is a $2.5 million expansion of their former technical building and expanded research center with special Research and Development facilities. In all, Fay Osborne earned 13 U.S. patents and many foreign corresponding patents during his career of 40 years at Dexter.

In a discussion entitled, "After ThreeMile Island" in DuPont *Context* the problem of educating the public on nuclear radiation and nuclear waste disposal was covered. The review included: "**Crawford Greenewalt**, former chairman and president of DuPont, was in the control room at Hanford, Washington, when the first nuclear reactor was put into operation. He has watched the nuclear industry's ups and downs, and has seen similar buffetings in the chemical industry." After T-M-I, he observed: "Problems are to be seen, appreciated, cured. In the nylon industry, we had accidents and we cured them. You uncover a design weakness, and correct it. In the 1940s we had a safety record three to one better than anyone in our industry, and ten to one safer than in all industries. Today, that record stands at 15 to one better than anyone in our industry and 50 to one safer than in all industries." We must work to make nuclear even safer, says Greenewalt, who is still a member of DuPont's board and Finance Committee. It could be argued that the accident at T-M-I is a fortunate thing because it spotted a design problem for us. The U.S. didn't get where it

is by running away from problems. We hope the public agrees with these words from an experienced source.

The Alumni Fund's annual report continues to be complimentary to the activities and generousity of the Class of 1922. We have provided a continuous and challenging record.

We are sorry to report the loss of classmate **Leo Freeman** of 2530 Terrace Ave., Baton Rouge, La.; and **Hobart A. Fischer** of Datona Beach, Fla.

You all have a pleasant winter as your secretary hopes to have — especially February and March at Lighthouse Point, Fla. — **Whitworth Ferguson**, Secretary, 333 Ellicott St., Buffalo, NY 14203; **Oscar Horovitz**, Assistant Secretary, 3001 South Course Dr., Pompano Beach, FL 33060

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Twenty-four of us arrived for our minireunion at the Ramada Inn, Mystic, Conn., on Friday afternoon, September 7: **Alan Allen**, Marge and **Shorty Chamberlin**, Phyllis Davenport, Regina and **Jerry Fitzgerald**, Vivian and **Dick Frazier**, Katie and **Herb Hayden**, **Dave Joy**, Ethel and **Elliot Knight**, Marion and **Bill LaLonde**, Harriet and **Bert McKittrick**, Pete **Pennypacker**, Mary and **Leander Poor**, **Al Pyle**, Isabelle Skinner, and Mary and **Royal Sterling**. Elinore and **Rod Goetchius** unfortunately had to cancel at the last minute owing to damage at their place in Vero Beach by hurricane David and the threat of oncoming hurricane Frederick. We congregated with Royal Sterling superintending the bar, became reacquainted, and heard the McKittrick bell rung, then dined together informally that evening.

On Saturday we were largely on our own; many of us went to Mystic Village, the Aquarium, and Mystic Seaport and Museum. That evening after our banquet, Pete Pennypacker played several numbers on his 'cello and gave a history of the 200-year-old instrument, and then lead the singing of his song "To M.I.T." Dave Joy treated us to a rendition of "Minnie the Mermaid." Alan's movies of the 55th reunion were shown plus some slides of the 35th and 45th reunions provided by Phyllis Davenport. Various prizes donated by the McKittricks, Phyllis Davenport, Pete Pennypacker, and the Sterlings were drawn by lot.

The **Paul Moores** drove over from Stonington for breakfast Sunday morning. After another round of "To M.I.T." and a round of cheers for the Sterlings in recognition of their considerable work in arranging and guiding the reunion, and for Phyllis Davenport and Isabelle Skinner for their loyalty and participation, all led by Pete Pennypacker, the reunion disbanded.

Alan Allen made a complete movie record of the occasion. Dave Joy and Jerry Fitzgerald made a few identifications of the R.O.T.C. pictures (*see the October notes*), fixed the time as summer 1922, and took them for further examination under magnification.

In accepting her election to our class (*see the November notes*), **Helen Whitaker** writes, "I am honored to belong to that illustrious group." Our only other living honorary member is **Wolcott A. Hokanson**, elected in 1953. Others were **Horace S. Ford**, elected in 1935, and **Samuel W. Stratton**, elected at graduation.

Julius Stratton and your secretary-treasurer attended the Alumni Officers' Conference, September 28-29.

Julian Loewus writes that he still goes to Hot Springs, Ark., for the mineral baths semiannually as he has for the past 30 years.

Bert McKittrick reports the death of **Edward S. Averell** while mowing his lawn in Lynnfield, Mass., on September 19. Ed graduated with our class in civil engineering, and Bert, Ed, and **Allen Parker** roomed together in their senior year. In addition to his vocation as a civil engineer, Ed was active in numerous fraternal, social, professional, and civic organizations.

The **Sun Transcript** of Winthrop, Mass., reports the death of **Francis L. Cronin**, formerly of Winthrop, in Lauderdale-by-the-Sea, Fla., on July 6. He graduated with our class in business and engineering administration. During World War I Francis was a pilot in the U.S. Navy; he was on the staff of the Institute's Department of Building Engineering and Construction between 1927 and 1930, and then became president of C. H. Cronin, Inc., mechanical contractors, with offices in Boston and New York. — **Richard H. Frazier**, Secretary-Treasurer, 7 Summit Ave., Winchester, MA 01890

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Through the untiring efforts of **Ed Moll** the colored photographs of the 55th Reunion group have been delivered. There is a noticeable lack of baldness among the white-topped, and about five who have retained that freshman appearance. If anyone has time to make a numbered identity sketch, we will arrange for assistance and distribution.

Unfortunately that group has begun to diminish. Rene and **Ed Moll**, Winnie and **Herb Stewart**, **Ray Lehrer** and **Russ Ambach** attended the funeral of Barbara Shaw, wife of our ex-president **Frank Shaw** on October 18. Barbs had not been well, but was ambulatory, when she suffered an unexpected relapse. She was president of the Massachusetts Shut-in Society, and, as Frank, active in civic organizations.

The Alumni Officers' Conference in September was attended by **Ed Moll**, **Frank Shaw**, **Herb Stewart**, **Gordon Billard** and your scribe. The latter believes that advancing age dampens the enthusiasm for the content of this event except for sociability, some of the Friday afternoon subjects and the Saturday breakfast hosted by the *Review* personnel affording change of ideas between Class Secretaries. The Conference appeared geared for past 1945 Alumni and that may be logical for its purpose.

The Alumni Records office received a letter reporting the death of **Richard W. Frost** of Newbury, Mass. Our files indicate that he was with us for three years after Northeastern University and had an O.E. degree (Ocean Engineering). In 1949, he was chief engineer for the Henschel Corp. and member of the American Society of Naval Engineers.

Robert S. Seddon died March 9, 1977. He was living in East Sandwich, Mass. Although his degree was in general engineering, he apparently had a U.S. Naval career, finally as the director of design in the Public Work Office, 1st Naval District, Boston.

A long letter from **Dave Kanter**, Great Neck, N.Y., details his current interest in teaching anyone how to read Yiddish. From an early age he taught Hebrew as an avocation and has now developed a new pedagogic technique so one can read Yiddish in a few lessons, already proven in Florida, by students who read newspaper mastheads quickly. Dave, as author, has a copyright for a recent pamphlet on "How To Read Yiddish." He is also proud of a grandson, now a junior at the Institute.

We are saddened to report the loss of **Nathan Schooler** on July 1, 1979, in New York City. A respected, friendly and very generous member, he and his good wife, Freda, rarely missed an opportunity for a Class get-together. He subscribed to a chair in the refurbished 10-250. Nat was very philathropically minded and devoted time and support to many Jewish organizations. He was chairman of the Federation of Jewish Philanthropies and United Jewish Appeal, both in Flushing, N.Y., and Queens United Jewish Appeal Campaign. He established and was president and treasurer of Flush Metal Partition Corp., on Long Island. Nat received his S. B. in mechanical engineering and was active in several Societies at M.I.T. His son, Jerome P., received his S.B. in Course XV in 1959.

A letter from **Al Roig**, Humacao, Puerto Rico, expresses his heartfelt appreciation for the thought and signatures sent to him from Exeter, one of the very few Reunions that he had missed. He hopes that his arthritic knees will not hinder attendance at the next one. Al proudly announces the birth of a second great-grandchild named after Saro. He believes that he is one of the leading progenitors of the Class.

Eleanore and **Bill MacCallum** have returned to Cotuit on Cape Cod after Bill continued to puzzle the doctors at Massachusetts General Hospital. He is not up to mowing the lawn yet, but moving in that direction.

George Tapley, Delray Beach, Fla., acknowledges with thanks the receipt of good wishes and 55th signatures, regretting his absence from Exeter, attended by Floridians **Paul Blampied**, **Joe Tryon** and **Gene Quirin**. — **Russell W. Ambach**, Secretary, 216 St. Paul St., Brookline, MA 02146; **Herb Stewart**, Co-secretary, 8 Pilgrim Rd., Waban, MA 02168

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A notice outlining some of the plans for the 55th Reunion should have reached you by now. I met with **Court Worthington**, **Will Gardiner**, and **Jim Howard** during the Alumni Officers' Conference in September. **Ed Kussmaul** was registered for the conference but failed to make it. A call from him later indicated that he had found his schedule overcommitted. Your reunion committee is busy, and I hope you will respond promptly to their communications.

Two classmates have been kind enough to write me recently. **Jesse Maury**, who resides in Chevy Chase, Md., sent copies of some recent publicity. Last March, Commissioner Joe Gebhardt, with the concurrence of the White House, appointed Jesse, a longtime political and civic activist as an alternate federal commissioner to the Interstate Commission on the Potomac River Basin. In his letter, Gebhardt wrote, "With your long interest in environmental issues and the Potomac River and your detailed knowledge of water quality in the Washington metropolitan area, I could think of no one better to serve as an alternate federal commissioner representing the president of the United States and the federal government." This commission is charged with finding ways to control and reduce water pollution in the Potomac and its tributaries. The commission consists of members from Maryland, Virginia, West Virginia, Pennsylvania, the District of Columbia, and the federal government. In July, 1979, Jesse was appointed to a post on the Washington Suburban Sanitary Commission. These appointments are but two of a series of accomplishments for Jesse, whose involvement in Montgomery County politics dates back to the 1940s. It is clear that he keeps extremely busy, for he works as a C.P.A. out of his home.

It was a pleasure to hear from **Don Henderson**, who reports that he and Adelaide celebrated their 50th wedding anniversary last July in good old Westport, Conn.

You should know that your secretary has been taken to task by two recent Institute graduates for using our class president's nickname when referring to his activities. As they put it, "There is *no* excuse for the appearance of a racial slur in an M.I.T. publication. We hope this never happens again." Of course we all know his nickname has been used for well over 50 years, and we have used it as an expression of our familiarity with and affection for our president. To change a nickname now is quite difficult — any suggestions

On a solemn note I have to report the passing of two classmates. **Walter D. Siddall** died in Clifton, N.J., on May 7, 1979. No details are available. News clippings carried the obituary of **George F. Mahoney**, who died at the Charlotte Hangerford Hospital in Torrington, Conn., on May 31, 1979. George graduated in civil engineering and had been active in highway and building engineering throughout his career. He had served as city engineer in Torrington from 1957 to 1960 and was cited for outstanding service to the city on flood control projects. He retired in 1970 as vice president of the Building Division of O & G Industries, Inc., and had been retained as a consultant since that time. He had considerable interest in astronomy and had taught the subject at the Torrington High School in the evening adult education department. George is survived by his wife Eva (Minnehan) Mahoney, three sons, three

sisters, and six grandchildren. — **F. Leroy (Doc) Foster**, Secretary, 434 Old Comers Rd., P.O. Box 331, North Chatham, MA 02650

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You read in the last issue of **George Warren Smith**'s experiences at the Massachusetts General Hospital and his faith in the superior therapy which would be afforded by the view of the sea as he sat on his terrace at Pigeon Cove. Since then there were additional hospital visits; and finally on October 15 we received the sad news of his passing. I had talked with him by telephone at the Addison Gilbert Hospital in Gloucester, and (as he was always innovative) he asked to have samples of elastic cords sent to the hospital superintendent, a close friend of his, to remedy a problem he had recognized.

That same day he sent a post card asking me as vice president to write some of the Class Notes from time to time. Subconsciously he may have been asking me to do what I am trying to do now. To be a secretary protem following Smitty's act is a tough assignment. However, after consultation with **Dave Shepard** I asked **Jim Killian**, our previous class secretary, to help. He responded by referring to the following obituary from M.I.T.'s *Tech Talk* on October 17: "George Warren Smith, '26, whose many services to M.I.T. earned him the Alumni Association's Bronze Beaver, its highest award, in 1964, died at the Addison Gilbert Hospital in Gloucester on October 15. Mr. Smith received his S. B. degree in business and engineering administration in 1926 and was employed for many years as a district sales manager for the du Pont Co. in Boston. After his retirement in 1964, Mr. Smith remained active in his own business.

Mr. Smith's enthusiasm for sailing led him to head an aggressive fund drive launched in 1975 to refurbish M.I.T.'s Sailing Pavilion and to replace most of its fleet. Against a goal of $212,000, Mr. Smith and his volunteer committee raised over $300,000.

"Earlier he had been a member of the Alumni Association's Executive Committee (1950-52) and seventh chairman of the Alumni Fund Board (1953-54), of which he was a member from 1948 to 1954.

"At the time of his death, Mr. Smith was a member of the Corporation Visiting Committee to the Department of Athletics and the Awards Committee of the Alumni Association. In 1947 he replaced his classmate James R. Killian, Jr., as secretary of the Class of 1926, and ever since then his accounts of his classmates' activities, generously supplemented with local color from Cape Ann, have been among the popular features of *Technology Review* for all its readers.

"Mr. Smith is survived by his wife, Ruth, of Rockport."

And then Jim went on with his own tribute: "I am honored by the opportunity to express with sadness and emotion the loss which we of the Class of 1926 feel so keenly. As class secretary, George built himself into the hearts of his classmates and friends. From his perch in Pigeon Cove he gathered together month after month intelligence about the activities, the accomplishments and happy reunions, and — all too many times in recent months — the deaths of members of the class.

"It was through his regular and comprehensive Class Notes that to an exceptional degree members of our class kept in touch over the years and became members of an interactive fellowship that gave a special character and friendly coherence to the class. In the fabric of our fellowship which he did so much to create, he leaves a gaping hole.

"The other day the wife of one of his friends and classmates remarked that George was a gentle man. He was also in the best sense a gentleman — generous, gracious, gay, and warm in his human relations. In consequence his friends were legion.

"He was an ardent photographer and he made a pictorial record of our class reunions that I hope can be preserved, along with his class notes, as constituting an admirable history of our class.

"George loved the sea, and it was characteristic of him that he should search out and find a lovely spot in Pigeon Cove upon which to build his charming home, which became a mecca that he and Ruth created for the class. Not only did his Class Notes report the vital statistics, the goings and comings, for the class, but he interlarded these reports with comments about life on the North Shore. These notes included weather reports and particularly vivid accounts of the storms, one of which two years ago tore away much of the area in front of his house; and George reported graphically on the reconstruction that was required to rebuild what the sea had destroyed. He spoke frequently of his joy in his Bull's Eye boat and of how he found refreshment and renewal in sailing it.

"The style of his writing and the character, completeness, and color of his Class Notes commanded attention not only on the part of fellow classmates but of others. I know that my wife always looked forward to his reports for their engaging content, and we all found interesting information and delight in the human insights and variety of life which were expressed in his chronicles. For all these good works and for the quality of his personality and character, those privileged to know him will always cherish his friendship and find in it a benediction.

"In behalf of the members of the Class of 1926, I express its sympathy for Ruth and appreciation on the part of M.I.T. for his unflagging loyalty, his assistance, and the superb example he set for all of us."

'Smitty's wish and Ruth's first announcement was to have a memorial service at the M.I.T. Chapel; however, for the convenience of many local friends, the location was changed to the Unitarian-Universalist Church in Rockport. The service on October 27 was simple, cheerful and very much Smitty. The church was full. Class members attending were: Liz and **Jim Killian**, Kitty and **Mal Hird**, **Stark Draper**, Mary and **Bill Meehan**, Ruth and **Ben Margolin**, **Morris Minsk**, Mary and **Don Cunningham**, and Evelyn and **Bob Dawes**.

Ruth invited us to her home, the house that Smitty built at Pigeon Cove, after the memorial service. Those of you who have been there know what a joy it always is to look toward the sea, of which Smitty wrote so many living notes. While there Ruth Margolin remarked to me how many times she had read the Class Notes in which Smitty made the whole scene come alive.

The Alumni Fund office (M.I.T., Room 12-090) is now receiving memorial gifts in Smitty's honor which will be used to purchase Laser class boats, one of which will be named for him at a christening this spring at M.I.T.'s Sailing Pavilion.

Smitty will always live on in the memory of his classmates and friends. But we must move forward, too, and so **Dave Shepard**, **Pink Salmon**, and I are endeavoring to enlist a permanent secretary and possibly an assistant secretary to help. — **Robert T. Dawes**, Vice President, 62 Washington St., Hudson, MA 01749

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At the fall conference of the M.I.T. Class Officers Dr. **Harold E. (Hal) Edgerton** was the key speaker at the dinner. As usual he presented very interesting pictures of his underwater project of recovering old hulks and lost treasures. He has cooperated for years with Jacques Cousteau and Hal's projects are equally fascinating even though Cousteau gets all the TV coverage.

Currently in Room 10-150 is an excellent exhibition of the photographs and life story of **Gjon Mili**. He has been a professional photographer since 1938 and contributor to *Life* magazine since then. The exhibition includes some of the photo essays utilizing lighting effects other than the strobe which he developed for photography.

The story of how two of our famous classmates helped each other is told in a new book *Moments in Vision, the Stroboscopic Revolution in Photograhy* by **Edgerton** and **Killian** (published by M.I.T. Press). Excerpts are noteworthy as events and circumstances, upon reflection, have steered our own careers in our early formative years. "It was Edgerton's good fortune to attract another enthusiast for flash photography who greatly widened Edgerton's audience and became a close friend. This was Gjon Mili, a senior electrical engineering student at M.I.T. when Edgerton was a first year graduate student. Mili first aspired to become a motion picture photographer, and after graduating went to Westinghouse to join a group working on electric lamps and their uses. There he became involved in testing the then-new chemical flash bulbs and gaseous light tubes and working with professional photographers in New York. The Boston Illuminating Society invived Mili to talk about lamps for photography at a meeting scheduled at M.I.T. Edgerton was on the same program with a demonstration of his electronic flash system. When Edgerton offered to bring a set of strobe lights to New York for trial, Mili borrowed a studio and arranged for a dancer to pose. This was the beginning of a long association with Mili. Mili asked, 'How can I get a set of these new lamps' Edgerton replied with the question, 'What will you do if I give you a set' The answer was, 'I will quit my job and start the first studio with strobe lights.' And so it happened, but with numerous conferences, changes in plans, and performances as the years rolled by.

"Mili was the leader in photographic application of the new system of lighting. His classical photographs are to this day models of imagination and technical skill. One of Mili's first accomplishments was a study in 1938 of Bobby Riggs for the then fledgling *Life Magazine*. To *Life*'s viewers it provided the pleasure of sudden wonder, and Mili was off and running as a successful *Life* photographer. The numerous flash pictures *Life* published in those early years helped to spread the fame of both Mili and the magazine." Other featured photos by Mili were in *Life* — July 8, 1940, Jan. 22, 1945, Feb. 7, 1956, and Jan. 1979.

Again we must report several deaths among our classmates. **Frederick A. Bodden** of Ramsey, N.J., died March 17, 1978. He was a Sales Engineer with Mirro Aluminum Co. of N.Y.C. **John W. Moore** of El Dorado, Ariz., died July 13, 1979. Our only record states he was an oil producer at the time of our fortieth reunion. **Bradford R. Stetson** of Punta Gorda, Fla., died on August 17, 1979. His entire career was with the Bemis Bag Co. and the Bemis Co., Inc., of St. Louis and Minneapolis. He started working in December, 1927, and retired in 1967. His sister writes enclosing a memorial gift to the Alumni Fund: "He had a great pride in M.I.T. and was gratified to be an alumnus." Mrs. Irene Ostro, daughter of **Samuel Clevens**, who died July 14, 1979, writes about her father. He received his S.B. in architecture and was designated in the Class of '27. He lived in Newton for the past 25 years and was a registered architect for several firms. His last association was with Whitman and Howard for many years before retirement in 1973. Since then he devoted his time to painting in many mediums which won him both recognition and awards. He was a member and exhibitor in the Newton Art Association. Besides his daughter, he is survived by his sister, and two granddaughters.

James Grote Van der Pool died in September, 1979. After receiving his S.B. in architecture from M.I.T., he furthered his studies at Harvard, the American Academy in Rome, and the Atellier Gromort in Paris. He served as the first executive director of the Landmarks Preservation Commission in the Office of the Mayor of New York. He served four years as chairman of design and construction for historic St. Luke's Church of 1632, near Smithfield, Va., the oldest surviving church of English origin in this country. At Columbia University he served for 14 years as professor of architectural history and as associate dean of the School of Architecture. He was administrator of Avery Library, long regarded as the ranking architectural collection in the world. He also served as president or trustee for the Preservation of Monuments and the Historic Preservation Society. He was a life fellow and a Benjamin Franklin fellow of the Royal Society of

Arts, in London, and received the George McAneny Medal for Historic Preservation. He was professor emeritus in architecture at Columbia and a fellow of the American Institute of Architects. He died in Santa Monica, Calif., and is survived by a daughter, a son, and ten grandchildren.

To the widows and families of these classmates, we express the sincere sympathy of the Class of '27. — **Joe Burley**, Secretary Pro-tem, 5 Hutchinson St., Milton, MA 02187

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Inasmuch as you will be reading these notes at or near the year's end, I will begin by wishing each of you pleasant holidays and a very good year ahead. At the Alumni Officers Conference in September your class was represented by Frannie and **Jim Donovan**, **Newton Foster**, Claudia and **Morey Kiegerman**, Anne and **George Palo**, Olivia and **Gus Solomons**, and Florence and **Walter Smith**. There were two days of informative and stimulating talks and meetings relating to Institute activities, interests, and plans. Understandably, much attention was given to the excellent progress of the M.I.T. Leadership Campaign. Now in its fifth and final year, it is obvious that the campaign will more than achieve the original goal of raising 225 million dollars. Alumni gifts are an important part of this total and here '28 can well be proud of its continuing and generous support.

Allan Tarr has proposed a somewhat novel way of providing aid to the Institute. In his letter to us Allan tells of a patent (for a security pocket) recently awarded to him. He has offered his patent to M.I.T. and suggests that others might find this a possible way of making a substantial gift. Upon question, D. Hugh Darden, director of planned giving at M.I.T., says that gifts of patent rights are welcome. Each such case is different, of course, and needs to be reviewed separately. We should also mention here that Allan is chairman of the Alumni Fund groups in Virginia and West Virginia which this year achieved excellent records of 68 per cent and 60 per cent respectively in alumni participation.

Writing to us from Rutherford, N.J., **Newton Foster** says: "Much to my surprise, two alumni whom I had interviewed as applicants for M.I.T., received alumni awards on September 29. Both Paul Shepherd '54 and Tom Farquahar '60 lived in Rutherford at the time I interviewed them. Looking back a few years, I note that I was appointed an honorary secretary of M.I.T. in 1940. During 1950 to 1951 the larger Educational Council was organized. At that time I was president of the M.I.T. Club of Northern New Jersey. Thus I have been interviewing students for entrance to M.I.T. for forty years!"

Paul Martini very thoughtfully sent a note enclosing a clipping from the *Washington Star* of September 25, 1979. Gen. **Ben Kelsey** is shown in a photograph with Gen. Jimmy Doolittle after Ben and his co-pilot Cole Palen, had just duplicated the world's first blind instrument flight that took place 50 years earlier in a biplane similar to the one in the picture. . . . **Hirsh Sulkowitch** spent a few days in the middle of October as a patient at Massachusetts General Hospital. In my telephone talk with Hirsh he said that he was there primarily for observation. . . . **Al Daytz** writes: "Dorothy and I are feeling fine. My immunization tests for prevention of recurrence of cancer has been successful. I still play golf and do a lot of reading and writing. Will see you at our 55th Class Reunion as promised." . . . Judith (Mrs. **Benjamin F.) Miller**, in correspondence with **Jim Donovan**, discussed how Ben had participated in the early kidney transplant work at Peter Bent Brigham Hospital in Boston.

While most of us have been retired now for some time a few are still fully active in business or profession. One such is **Edward R. Stevens** who, after more than a half century in the insulation business, has launched forth into a new enterprise. The *Burlington County* (N.J.) *Times* of February 15, 1979, gave a full account of Ed's new venture, a company under the name of Insulation Industries, Inc., in Hainesport, N.J. The product is an asbestos-free insulating cement and Ed is highly confident that it has a great future. To you, Ed, our admiration and very best wishes. With deep regret I must report the deaths of two classmates. **John Carvalho** died on September 3, 1979. John graduated in Course VI and began his career as an electrical engineer. In the lean days of the depression he turned to the field of education, studied at Boston University and received his M.A. in education (cum Laude) in 1943. He was a high school mathematics teacher for 14 years then became principal of a large grammar school in his hometown, Fall River, Mass. Following retirement from this latter post in 1963 he and wife Marjorie enjoyed several years of travel together. For the last nine years John was troubled with an ailing heart and more recently with additional physical impairments. He was dedicated to his work and it is certain that his influence will long endure. We are grateful to Marjorie for her letters to us and extend our sympathy to her, their son Alan and daughter Dorothy (Noble).

Mortimer C. Budlong died on October 6, 1979, following a brief illness. Bud graduated in Course XV and started his business life with Westclox in Peru, Ill. Over the years he advanced in the company and retired in 1962 as general manager of the Westclox Division of Talley Industries, La Salle, Ill. Following retirement he moved to Boston and did work for the Massachusetts Crime Commission and for Harvard University. Besides his wife Alice, Bud leaves his daughter Paula (Cronin) and son Thomas (M.I.T. '59). . . . We also have recent word of the death of **Valentine W. G. Wilson** on October 15, 1979. To the families of these classmates we extend our heartfelt sympathy on behalf of the Class. — **Walter J. Smith**, Secretary, 37 Dix St., Winchester, MA 01890

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A brief note from **Henry F. Robbins** says, "Thanks for the birthday card and reminding me that I am a year older." Henry has a unique and timely hobby, collecting miles per gallon (m.p.g.) data on his 1973 Vega sedan since he first purchased the car in April, 1973. Here are some of the results: 1. Worse m.p.g. figured over one filling: 21. 2. Best m.p.g. figured over one filling: 49. 3. Worst m.p.g. figured over 4 fillings: 28. 4. Best m.p.g. figured over 4 fillings: 42.5. To get good results, he keeps his car in tip-top shape — front end aligned, tires properly inflated, motor tuned up, and speed not exceeding 55 mph. He also drives with his lights on during daylight hours as additional protection. He and his wife Anne share another hobby. They have created Gillette Gramaphone Group, a private group of persons who informally sample new releases of classical music on discs and cassettes. This idea takes me back to our undergraduate days when some of us used to listen to recordings of classical masterpieces conducted by famous maestros such as Toscanini, Koussevitsky, Stokowski, Beechum, and Mengelberg, who have long since vanished from the scene. What little music appreciation I have, I owe to those informal gatherings at Walker and Friday afternoon concerts at the Boston Symphony (student rush seats for 50¢). I envy Henry and Anne, since we also had a similar group who gave regular recorded concerts with program notes and intermissions. As many as 50 used to attend these concerts held in a small hall near Tufts. More than half of those who attended were from Tufts and Jackson. On at least one occasion, President Charmichael and his wife accompanied a score of students to a concert.

Charles Frank, Jr. writes, "I am somewhat late in sending my class gift this year because my wife and I spent five months at Winter Haven, Fla., and we have just returned. We certainly enjoyed our stay — every minute of it. . . . **Samuel J. Levine** is still active doing consulting work (with a reduced work load) representing National Executive Service in the Boston area. "I attended our 50th reunion — my first," he continues, "and saw a bunch of old men and women. Seriously, it was great to see some of my classmates whom I had not seen since graduation. Best regards to all." . . . **James B. Magenis** says in French, "No news is good news — it is getting tougher each day to keep up with inflation." Jim and his wife Marjorie were present at our recent 50th reunion as well as most of the past 5-year reunions. He was associated with Pan American World Airways as a captain and assistant chief pilot until his retirement in 1968. For the next five years, he taught mathematics at Easter Military Academy. Now he is completely retired and busy keeping track of his growing family. Present count: three children and nine granchildren.

Robert W. Gray, Jr. is still working part time in his own business. He and his wife Sally are bright and cheerful and enjoying life in spite of some health problems. They enjoy walking and swimming. . . . In July, Mary and **Frank Mead** flew to Cashel County Gatway (Island) with friends from Marion, Mass. to fish the Ballyahwick River. The salmon fishing was poor and it rained 14 out of the 16 days. But the company, the scenery, and the food at Cashel House was superb. They plan a similar trip for 1980. Frank has been one of the most active members in class and M.I.T. affairs. In addition to being president of our class from 1969 to 1974, he has been class agent, member of the M.I.T. Development Corporation, chairman of the 50th reunion gift committee, and a member of the M.I.T. Educational Council. His career has revolved around A.T. & T. and New England Telephone in engineering, sales, rates, marketing, and finance. His hobbies include golf, fishing and lobstering, bird hunting (quail, grouse, and woodcock), deer hunting, and gardening.

Edward B. Papenfus writes, "My wife Gwen and I are enjoying our retirement years here in Vancouver, B.C., though I seem to be as busy as ever. I continue to enjoy good health, but unfortunately my wife suffers almost continuously from a bad back. I am very concerned about the value of the dollar, which continues to suffer owing in part to irresponsible politicians. I have come to the conclusion that the only way to protect one's assets is to convert into gold, even at $320 an ounce. In my opinion, the rush to buy gold has not even begun yet." . . . **Everett F. Kelley** writes, "On June 17 we celebrated our 50th wedding anniversary, a monumental occasion, at the home of one of my sons. It is a once-in-a-lifetime affair and we are thankful we made it. We visit Florida every winter for three months with close friends. We enjoy walking a lot. We leave our car at home and walk five miles a day. At this rate, we should live to a ripe old age.

I have a note from **Bill Baumrucker**, past president of our class, saying, "Many thanks for your faithful birthday greetings. It was a great year for travel, plus the big highlight of the 50th reunion at Chatham Bars. Travels included a fishing trip in January with **Wally Gale** and **Frank Mead** for black marlin off the coast of Panama. Then we went to the Bahamas and Virgin Islands in March with Helen and **Tom Speller** and Olive and **John Rich**. In May, Doris and I cruised down the Nile, going from Aswan to Cairo. Our ship sank in the middle of the Nile during a tornado the first day out of Aswan. We were rescued by some natives in boats and after 24 hours without food, we were transferred to another boat to resume our cruise. Miraculously none of the passengers and the crew of 55 were hurt. It was great fun, since it ended well. We lost all our baggage, but the insurance company took care of that. After our big event at Chatham, Olive and **John Rich** joined Doris and me for a trip to Scotland for salmon fishing. We stayed in an old castle and were treated royally. We also took a motor trip through the Suglish lake region, Wales, and Lorna Doone country. We came home to rest, play tennis, and catch up chores. Bill has been an active member of our class, attending most of our major five-year reunions with his wife. He was president of our class from 1974 to 1979. He has had a varied business and professional career in structural design for Curtis-Wright (1929-1931), assistant production manager and assistant to the general manager for the *New York Daily News* (1931-

1950), business manager for the *Boston Herald* (1952-1955), and senior vice president for Charles T. Main (1960-1975).

Hyman J. Fine is semiretired from his post with the Corps of Engineers in Norfolk, Va., but does consulting work three days a week on water resources planning. He plays tennis regularly and his wife Edythe is active in organizational work and at home. His professional work has involved planning, investigating, supervising, and operating water resource projects in the South. His projects concerned navigation, beach erosion, flood control, hydroelectric power development, and water-based recreation. His hobbies include ancient Egyptian and Israeli archaeology. He says "Sorry we could not make the 50th Reunion. My very best wishes for all the '29ers."

During September's Alumni Officers' Conference at the plush Hyatt Regency Hotel and M.I.T., where Doris and **Bill Baumrucker** joined your secretary and his wife Helen, two of our distinguished members, **Paul V. Keyser** and **John J. Wilson**, were recipients of the 1979 Presidential Citation. The award was given to the Building 10 sponsoring committee in grateful recognition of distinguished service to the M.I.T. Alumni Association. Also, on October 11, the Marshall B. Dalton, '15 Award was presented by the Corporation Development Committee to **Paul V. Keyser** for his exceptional service to M.I.T. An inscribed Paul Revere bowl was also presented to him by Howard W. Johnson, chairman of the Corporation. — **Karnig S. Dingian**, Secretary, 10 Ancient Highway, Hampton, NH 03842

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Several times a year I receive an unsolicited letter from a classmate, and I am always heartened thereby. This month's volunteer is **Howard Reed**, who writes from Cape Coral, Fla., to call my attention to the death (in January, 1978) of **Bob Sauerwein** who, according to Howard's recollection, introduced Tech to lacrosse. Bob graduated from Johns Hopkins where he became a lacrosse enthusiast. When he came to M.I.T. to do graduate work in aeronautical engineering, he promoted and was the first coach of an M.I.T. lacrosse team, on which Howard was a "rather hapless goalie." As Howard points out, lacrosse at M.I.T., like the class of '30, will have a 50th anniversary next year.

Dick Phillips reports that he and Evelyn are "salmon fisherfolk." Last May they traveled 55 miles north of Ketchikan, Alaska, for king salmon, and in June they went to Moosehead Lake in Maine for landlocked salmon. The Phillips and the **Frank Nettletons** get together for lunch and bridge several times a year. . . . As many of you know, **Ralph Peters** retired from Eastman Kodak in January, 1972, as assistant superintendent of the Paper Mills Division. After his retirement he and Phoebe did considerable traveling until her death some years later. Ralph has continued to live in Rochester and lists his activities as gardening and travel. However, it seems fair to say that his most important job at the moment is promoting a respectable 50th-year gift for the class of 1930 to present to M.I.T. next June. He and **Dick Wilson** have joint responsibility on this project, and by the time these notes appear they will be working on the homestretch. I suggest that they deserve your help.

Jack Osborne started working for M. W. Kellogg Co. (now Pullman Kellogg) in 1930 and stayed with Kellogg until he retired in 1971 when the company moved to Houston. His work was mostly in process engineering of petroleum refining units. Since then he has been quite busy as a consultant for Kellogg and has spent considerable time on foreign assignments. The Osbornes live in Chatham, N.J., where they occasionally see **Tul Houston** who lives nearby. They also saw **Herm Botzow** a couple of years ago. . . . We have a note at hand from Genevieve telling us that her husband **Harold Plant** has run into some health problems. The Plants are living at Crosslands, a retirement community in Kennett Square, Penn., where Harold is permanently confined to a hospital with Parkinson's disease. Genevieve has a small apartment to which she can bring him when he is well enough. In any case, they see each other every day and enjoy the swimming pool together.

We have a notice at hand that **Charles (Chuck) Twelves** died on July 10, 1979. According to my records Chuck retired about ten years ago as assistant vice president for engineering of the Pacific Northwest Bell Telephone Co., where he was on the headquarters staff. The Twelves lived in Walnut Creek, Calif. In addition to his wife, he leaves two daughters and four grandchildren.

Shifting to a more upbeat item, it has been some years since I have had an opportunity to report the marriage of a classmate, and I am particularly pleased to note that the marriage I am about to report is mine. On October 16 I was married to Louise Mann McCarroll, originally from Swanquarter, N.C., and more recently a resident of Heritage Village, Southbury, Conn. As many of you know, I have lived for some 40 years in an area of Harrison, N.Y., known as Winfield Glen. During the years 1955 to 1970, Louise and her husband lived in the same area, just up the street from Marion and me. For a number of years Marion and Louise drove the same Red Cross unit and I used to collect for the Community Chest at their house. Shortly after the McCarrolls moved away, Louise's David and my Marion died within a few months of one another. We became reacquainted about a year ago and thereafter matters proceeded with all deliberate speed. Our present plan is to live in the Harrison house until my retirement becomes effective on February 1, 1980, at which point we will begin living in Louise's unit at Heritage Village. Also, we shall be exploring the possibilities of a winter home and will be happy to consider any suggestions you may care to offer in this respect. I may say that I am rather eagerly anticipating the chance to introduce Louise to those of you who come to the reunion next June. It seems fair to say that among those attending 50th-year reunions, newlyweds may be rather rare. Those of you who are still vacillating as to whether you will come should bear in mind that one of the "perks" of attending will be an opportunity to meet my bride. Remember the place and date: Chatham Bars Inn, Sunday, June 1, 1980, et seq. — **Gordon K. Lister**, Secretary, 530 Fifth Ave., New York, NY 10036

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Congratulations to **Dick Kropf** upon his retirement as president of Belding Heminway Co., who was honored by a retirement party on June 7th. Following graduation, Dick joined Belding Corticelli, was named director of research in 1943, vice president in 1949 and has served as president from 1961 until his retirement this year. He will continue to serve Belding Heminway as an active consultant and director. . . . **Art Bertolett** writes that he retired from The Philadelphia Electric Co. as assistant chief system planning engineer in 1974. Since then, Art has been active in the Episcopal Church, the Sons of the American Revolution and fraternal organizations.

A most welcome letter from **Addis E. Kocher** syas "On September 24, 1979, I had the pleasure of paying tribute to two older M.I.T. graduates. The occasion was the 50th anniversary of the first air craft "blind flight." . . . the pioneer was our own Brig. Gen. "Jimmy" Doolittle, M.I.T. '24, whose back up was Brig. Gen. Benjamin S. Kelsey, M.I.T. '28. It was a great pleasure for me to present Gen. Doolittle with a framed photograph of him with another great pioneer, Wiley Post, whose airplane I was working on in the hangar. The hangar was run by Buzz Aldrin's father (both M.I.T. men) and I installed all of the high altitude equipment for Wiley to fly transcontinental at 30,000 feet. This was a "first" and was under contract with T.W.A. Before I retired from Bendix 7 years ago, I contributed to the development of the auto pilots for the 747 and DC-10 airplanes. I am still busy making jewelry, having taught lapidary and silversmithing for 8 years in a local high school at night. I am also a beekeeper of 32 years."

Although I haven't missed the New England winters since moving to Florida, I have missed the autumn foliage. About the middle of September, Helen and I (E.S.W.) flew to Washington, D.C. for a few days, then went on to New York for a couple of shows and lunch with an old friend of Helen's, after which we went to Boston for the M.I.T. Class Officers' Conference. I enjoyed showing Helen around M.I.T. but was sorry that no others from our class attended the banquet and meetings. After that, we took off for northern New England where the foliage was at its height. En route, we stoped over in Jaffrey Center, New Hampshire, and saw Harriet and **Ed Blake**, who spend their summers there. In the winter, their address is 160 Starford Drive, Englewood, Fla. 33533. Harriet was just recovering from some back trouble but seemed to be feeling much better when we saw her.

With all good wishes for a merry Christmas and healthy and happy 1980. — **Edwin S. Worden**, Secretary, P.O. Box 1241, Mount Dora, FL 32757; **John Swanton, Jr.**, Assistant Secretary, 27 George St., Newton, MA 02158; **Ben W. Steverman**, Assistant Secretary, 3 Pawtucket Rd., Plymouth, MA 02360

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At the Alumni Officers' Conference this September several of us from the Class of 1932 got together and held our own meeting. Those present were **Nick Flatley**, **Ed Nealand**, **George Kerisher**, **Wendell E. Bearce**, and myself. Our first order of business was to elect Wendell our vice president in recognition of his interest in class activities and good attendance at meetings and functions. **George Kerisher** reported that our class treasury was in good condition and adequate for our responsibilities. **Nick Flatley** reported that he felt it was the consensus not to have a minireunion but to concentrate on the 50th, which is only about two years away. He also reported that **Bob Semple**, chairman of the 50th reunion gift, thinks we have an excellent chance to make a record-breaking class gift to M.I.T. It was decided that, as class officers, we should concentrate on getting the class of 1932 to have the highest per cent of contributors ever. This is very possible — you'll hear more later.

Lee T. Tyburski writes that he has sold his home in Cherry Hill, N.J. and is about to move into his mountain retreat in the Poconos. Very pleasant and quiet — good hunting and fishing in Lake Blytheburn. He and his wife are planning their third trip to Europe.

I recently attended an M.I.T. seminar entitled "Capitalism: An Endangered Species" . . . There I met our classmate **Archie Riskin** — a course IV architect. He informed me that he had been doing commercial architecture for his own company for many years. Although he considers himself semiretired, he still is active in the field. His wife Leona, who had been on the staff of Simmons College for many years retired but is now working for M.I.T. Historic Collections. The Riskins' hobby is traveling throughout the world. They plan to attend our 50th reunion.

Alumni Records sends us the sad news that **Robert D. McGilvra** of Princeton, N.J. died May 17, 1979. **Herbert H. Brown** of Carmel, Calif., died in 1974. We also received the obituary of **Daniel P. Dyer, Jr.** of Detroit, Mich., who died on June 18. He had retired six years ago from Budd Co., where he was manager of test engineering. He received his master's degree from M.I.T. in 1932. His survivors include his twin sister Myrtle J. and his two sons Daniel P. III and Charles W.

I wonder what I'll have to write about in the next issue, as all my material has been printed. Maybe the mailman will bring me lots of letters. I can dream, can't I — **Melvin Castleman**, Secretary, 163 Beach Bluff Ave., Swampscott, MA 01907

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Headlines this time are for that fine group of classmates who attended the Alumni Officers'

Conference: Georgia and **Bill Barbour**, Helen and **Bill Baur**, **Ed Simpson**, Dorothy and **Stan Walters**, **Westy Westaway**, and yours truly. We enjoyed the wine festival and then the dinner. **Frank Gilmore** and **Beau Whitton** were not at the dinner, but might well have attended the other parts of the two day event. I always enjoy seeing Beau and was looking forward to meeting Frank for the first time (I think). In any event, this group represents a surefire cross-section of a great class. I regretted no end that Leona could not be with us, due to illness. She misses these occasions.

Bill Baur writes that he was married a day or so after the conference to Helen. They then took off for Paris and the French Alps, and thence to the place of Bill's birth, Stuttgart. He surprised some of his relatives showing off his brand new bride. Typical of this tireless worker, he expects to set up a dinner meeting of the Tampa Bay M.I.T. Alumni Club. Bill is an officer of the club and hopes to get to the Mexico City club next spring, and perhaps, also Hawaii. Many thanks, Bill, and the Class wishes you all that is good in your new marriage.

George Henning sends a clip of **Ralph Cross**, who has been named president of the board of directors of the Society of Manufacturing Engineer's Engineering Education Foundation. This foundation was established to provide financial support to manufacturing research projects, and is aimed at other activities for improving productivity as well. The clip also has a photo of Ralph which cannot be copied — a fact that I regret, as it shows Ralph with a big grin on his pan, where ordinarily he is shown sober-faced. We hafta admire this great fellow, and are pleased that he is one of ours. Now, George and Lucy add a bit: spent the summer on Long Island, and enjoyed it, but we note that they took off for Deauville, France for a chief executives' meeting, and then a relaxing week in the Bordeaux area.

We have a short message, personal, from **Bill Harper**, enclosed with a rather long note to **Dayton Clewell** (Xerox), which turned out to be a nostalgic biography, all of which has been covered here before, though piecemeal. I regret that the text is not part of this news story, and beg Bill's pardon. Anyway, he is going to make the 50th come hail and high living. **Thomas George** takes an unusual way to tell his story. It seems that he wished the addresses of two '34 men, so he wrote to Bob Franklin, Secretary of 1934, asking for the info. However, to save writing two letters, he wrote his Biog on the note to Bob Franklin, who graciously sent the works to me. To whit, thanks, Tom, your story is still worth an adequate repeat. Tom spent many years with the airplane, but started with E.C. Budd Co., Philadelphia, manufacturers of railway equipment. He was with them ten years, in engineering. He then went with the Naval Aircraft Factory of the Philadelphia Navy Yard. After six years in engineering with the yard, he went with Vega, a subsidiary of Lockheed, and stayed with them for 36 years. Practically all his experience with Lockheed was spent in engineering and flight test, and he was fortunate enough to have had experience on all models of aircraft built by Lockheed. Surely a remarkably satisfying 36 years. Tom retired in 1974, and his retirement got him into a few projects of his own, though he has one more taxing, president of Angeles Public Shooting Ranges, Inc. Tom says that this does not pay too much, and there is no limit to the time that can be involved. Tom, we do appreciate your biog. Don't forget the 50th Reunion, and class gift.

Now we come to the Fund capsules. **Robert A. Dobson** tells us that he is serving his second three-year term on the board of governors of the American National Red Cross. Still chairman of the Doane College Board of Trustees, now board chairman of Dobson Bros., and still quite active in business affairs. Keep busy, son. You may have more. . . . **George Wrigley** is chairman and chief executive officer of the J. E. Sirrine Co., engineers and architects. Only two capsules this time.

The irresponsible **Walt Skees** sends us a card from Spain, with inserted three positive slides of beautiful spots in Barcelona. Thanks, Walt. . . . A newsclip tells us that **Alfred G. Paybe** has passed on. . . . A note from **Bob Timbie** reminds us that he and Al went to Newton High together. The clip reminds us that Al moved to Sun City, Fla., five years ago, but did not mention that he moved there from a suburb of St. Louis. Al was with Monsanto for 36 years. We have written to Mrs. Payne. . . . Alumni Records informs us that **Francis T. McDermott** passed away in Chicago, Feb. 1978. We have no further information. One may see this glaring case of no one making any attempt to notify anyone at all when a classmate has passed on. Again, may I implore you to remind someone in your family to notify Alumni Records, the Alumni Association, your class secretary, or just plain M.I.T. Cambridge, Mass. 02139, that an alumnus has passed on. It is easy now, and it is not after you have gone.

And, do not forget the 50th Reunion gift! Someone will call on you, never fear. Be ready with as generous a pledge as is possible. Holiday greetings to you all from Leona and Warren. — **Warren J. Henderson**, Secretary, Fort Rock Farm, Drawer H, Exeter, NH 03833

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This month I have some items that were prominent enough to be the subject of news releases that came to me. If you recall the bitter fight that resulted from the attempt by Curtiss Wright to take over Kennecott Copper, you were probably pleased when **Frank Milliken** was able to fend off the take-over attempt. After seeing it through, Frank retired as Kennecott chairman and has now been honored by the Board of Directors. Kennecott is the parent company of the Ozark Lead Co., and since the 1960s Frank had worked towards a major expansion of their operations at Sweetwater, Mo. Early in August work started on the expansion project and as the work began, the Board directed that the entire facility be designated the Frank R. Milliken Mine.

Also in August, **John Newell** was elected a trustee to the board of fellows at Bates College. John is a former president and director of the Bath Iron Works and has served on the board of overseers of Bates as a trustee since 1958. As you may know, all of John's career has been associated with shipbuilding. He is a former naval officer, past president of the Society of Naval Architects and Marine Engineers, and has received honorary degrees from Bowdoin College, the University of Maine, Nasson College, and Stevens Institute of Technology.

Although Mallinckrodt Inc., maker of specialty chemicals and pharmaceuticals, has named their president to the additional post of chief operating officer, our **Hal Thayer** continues as chairman and chief executive officer.

Once more, the unhappy business of reporting losses. In August, **G. Roy Fugal**, who received his S.M. in Course XV with us and went on to a fulfilling career, died in Milford, Conn., at the age of 72. He had started with G.E. in Bridgeport in the appliance and merchandise department in 1935 and had several important patents in connection with the watt-hour meter. While at M.I.T., working with others at the Harvard Medical School, he helped develop a thermodilution coupler that is used to measure vascular blood flow. For some years before his death Dr. Fugal had been Manager of Personnel Practices — with corporation-wide responsibility in this field. For years he had been very active in the Mormon Church, both in Connecticut and all of New England. He had served the longest continual chairmanship of a State Apprenticeship Council in the United States; and had been a lecturer at both Yale and M.I.T. Dr. Fugal is survived by his wife, a son, two daughters, and seven brothers and sisters.

Unfortunately, I have no information about our other loss, **Luis Sanchez** of Lorain, Ohio, except that he died more than a year ago. But to both families I would extend our sympathy and condolences.

Two final items come from Alumni Fund notes. **Fred Judd** writes, "Moved my company, the Aerocoustic Corp., including manufacturing operations (from Long Island-RMF) to Jacksonville, Fla., in June, 1978." . . . A little more voluably, **Jerry Hudson** says "Been sailing (my retirement obsession) on the high seas in a 56-ft. ketch — West Indies, Bermuda, Newport, R.I., etc. Now catching up on my mail before returning to my 'natural environment'." Since the note was postmarked Ft. Myers, Fla., that seems to be Jerry's home base.

We were a little thin at the A.O.C. at the end of September. Besides myself there was **Roger Williams**, **Walter Wise**, **Carl Wilson**, and **Johnnie Hrones**. Johnnie was still in Jaffrey, N.H., but by now will be back in Florida.

The November notes sneaked by my time frame and since these are for the December-January issue — depending on when you read this, I hope you all have — or had (pick one as you choose) a happy and successful holiday season. — **Robert M. Franklin**, Secretary, P.O. Box 1147 (620 Satucket Rd.) Brewster, MA 02631; **George G. Bull**, Assistant Secretary, 4601 N. Park Ave., Apt. 711, Chevy Chase, MD 20015

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I am happy to start off this issue's notes with a letter from **Ellis Flink** who has lived in Providence, R.I., all these years working at B. Flink and Sons, a produce wholesaler. He writes, "After reading the most recent issue of *Technology Review* and noting the great number of our class who are retiring, I thought I should add one more to the list. I retired on July 1 thinking that this would help my game of golf. While I have enjoyed the first few months, I can assure you that my game has not improved, that no one should fear that I will take the cup next season. I went to Copenhagen a few weeks ago to visit my son. He is a professor and heads a department at a college in Copenhagen. I am expecting my daughter to give us our second grandchild in a few weeks. Now you have all the news about me that is fit to print." Congratulations on your retirement, Ellis, we look for you to come back in the Class Tournament next season. The 19th Class Golf Tournament is now down to the final two protagonists: **Alfred Johnson** from Reading, Mass., and **H. William Parker** currently of Bella Vista, Ark. The interesting part of this is that these two grew up and went to school together in Keene, N.H., and now, 50 years later, they are playing a golf match by mail to determine the Class Championship. Marjorie, Bill's wife, told me on the phone this evening that they will be in Massachusetts at Thanksgiving and will be in touch to take the prize home. Now that is positive thinking! Anyway, I'll announce the winner in the next notes. I would like to announce the flight winners who played each other to determine the above finalists. **Les Brooks** won the cardinal flight and was edged out by **Bill Parker** who won the grey consolation flight while **Gerry Rich**, winner of the grey flight was eliminated by **Al Johnson**, cardinal consolation flight winner. It's the first time the consolation winners have both ended in the finals. There must be something to that "just give me another chance" business.

Our 45th Reunion plans are taking shape and a sizable committee is involved. By the time you read this you will have received **Bernie Nelson**'s letter outlining the detailed reunion festivities which start Thursday, June 5th, and go through Sunday afternoon, June 8th. I hope you are planning to be there to see old friends and compare notes. We will miss Arthur Feidler but the Pops Orchestra will be superb as usual. And we are very fortunate that Bernie was able to get us into the private Wianno Club in Osterville on an exclusive arrangement; we will have it all to ourselves.

Richard F. Jarrell, principal scientist and manager of the Optical Emission Spectrochemical Applications Laboratory, Jarrell-Ash Division of Fisher Scientific Co., was named the recipient of the H. V. Churchill Award by the American Society for Testing Materials. The award was presented at ceremonies held in Orlando in September. — **Allan Q. Mowatt**, Secretary, 61 Beaumont Ave., Newtonville, MA 02160

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The timing of the writing of these notes is most fortuitous: preceding the mini-reunion but after the mailing went out. I can share with you some of the early responses. Before he had received the mailing **Marshall Holcombe** wrote from Naples, Fla., and herewith is a portion of his letter: "I have just received a note from Dorry Ober disclosing that our classmate, **Philip L. Ober** died September 7 in Boston of cancer of the pancreas two days after exploratory surgery. He had been in something less than good health all summer and finally went to Boston for expert attention. For the past five years Phil and Dorry lived in retirement in the beach community of Southhampton, Long Island. They had visited us in Naples the past two winters and according to Dorry they have had five great years following Phil's early retirement." The 1967 Alumni Register listed Phil as director of operations, Radio Receptor Division of G.I. in Hicksville, N.Y. The Obers' retirement address was North Sea Beach Colony, Southampton, N.Y. 11968.

Marshall continues by saying that he had recently spent more than a week at the Miami Heart Institute following an unplanned stay in the intensive care unit of the Naples Community Hospital. He may eventually have multibipass heart surgery and meanwhile is taking "a frightening array of pills" to compensate for having been born with "about half the arterial system most people have." Vivivan and Marshall divide their time between Hilton Head Island and Naples. They have two married daughters, three lawyer sons and ten granchildren at this time. Marshall interviews applicants for admission to M.I.T. from south Florida. Two of his interviewees, including one female, are currently freshmen! (or freshpersons!) at the Institute. If you are in the Naples area do look him up.

George Webb responded from La Jolla, Calif., where he has been living for 23 years and is now retired: "After spending most of my career doing engineering work in the atomic energy field, I retired on March 1, 1978. I now spend my time sailing, camping, gardening, etc. Although Betty and I both have our roots in New England, we could not think of a better place to live than here in La Jolla." Their three daughters all live in California, two close by. They have five grandchildren. George and Betty look forward to our forty-fifth!

Gerry McMahon also hopes to attend our forty-fifth. He retired from Cities Service late in 1968 and he and Catherine have remained in Lake Charles, La. They married off a son and two daughters this past year and have perforce been very busy. They are also very involved locally but plan to take time out to visit their youngest daughter and her husband in Germany next summer.

Ed Dashevsky has announced his retirement from Raytheon on December 1. He plans to continue to do management consulting with Raytheon and other clients. Ed and Rose moved to Swampscott in 1977 and are enjoying living right on the ocean. Concurrently I received a clipping showing a picture of Ed and **Loreto Lombardi** as forty year members of the New England Section of the American Institute of Aeronautics and Astronautics.

One of our class "Petes", **Francis S. Peterson**, from Beacon, N.Y., comments that it is gradually getting harder for him to get around. He had an acute case of polio in 1944. Since it is harder for most of us we can sympathize especially with someone who has more than the usual problems. Pete retired from Texaco as a senior technologist last February after 42½ years as editor of *Lubrication* magazine. He says that he is thoroughly enjoying retirement and now takes seven days a week to do what he used to cram into two-day weekends. The Petersons' son Kenneth was featured on Evening Magazine as a "Weekend Warrior" he is an Eastern Airlines pilot and an F-106 fighter interceptor pilot for the Massachusetts Air National Guard. . . . **George Ray** is vice president of the Mundelein Savings and Loan Association in Mundelain, Ill., a northern suburb of Chicago. From 1936 until 1970 he served as an aerospace engineer with McDonnell-Douglas, Bell Aerospace and Boeing, from which he took early retirement "when they turned out the lights in Seattle." George and Nancy have three daughters and two grand-daughters. They live in Libertyville, Ill.

The Alumni Office reports the deaths of two graduate members of the class: Royal D. Sloan, who was dean emeritus of the College on Engineering at Washington State University, died in Boulder, Colo., on September 17 at the age of 88. He was an assistant professor of electrical engineering at Yale before joining the Washington State Faculty in 1922. He received an S.M. in 1936.

Jere Jennings, Emeritus Professor of Civil Engineering at the University of Johannesburg, died on August 26 in Johannesburg, South Africa.

Before the next notes are due I hope to have heard from more of you and will have seen some of you. It is a pleasure to hear from you — just love to receive letters! — **Alice H. Kimball**, Secretary, P.O. Box 31, West Hartland, CT 06091

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Robert J. Ferguson, Jr., has been promoted from executive vice president engineering and research to senior vice president and assistant to the president, United States Steel Corp. . . . **Duane O. Wood**, after retiring as president of Lockheed California Co. in 1976, performed consulting work for Lockheed and other U.S. and Asian firms. Then he lived in London for two years while executive president of Tried Holding Corp. He and his wife Beverly have now returned to Los Angeles, Calif., where he is semiretired. . . . **Douglas M. Carter**, 620 Wallis Rd., Rye, N.H., 03870, retired from Portsmouth Naval Shipyard on September 1, 1978. In addition to "maintaining home" he and his wife are attempting to rejuvenate their 100 acre farm in Salem, N.H. His wife's main interests are attending opera, symphony and theatre in the Boston area. Stephen, his oldest, is married, has one son, and teaches at St. George School in Middleton, R.I. John is married, has four children and is a music supervisor in public schools of Hanover, N.H. William is single and is building houses in Houston, Texas. The Carters are spending early spring in Bermuda and hope to travel more.

It is with deep regret that I report the death of **Charles Peyton Witsel**, who died of cancer April 17, 1975. The address of his widow is: Elizabeth R. Witsel, P. O. Box 24, Hendersonville, Tenn. 37075. — **Lester H. Klashman**, Assistant Secretary, 198 Maple St., Malden, MA 02148; **Robert H. Thorson**, Secretary, 506 Riverside Ave., Medford, MA 02155

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Sid Mack writes that he has joined the ranks of the retired, leaving the mathematics department of Penn State.

Every time I hear about **Norm Leventhal**, he's involved in another extracurricular activity — this time he's chairman of events sponsorship for the United Way. Norm, how do you earn a living?

We received notice that **Alan Hardman** passed away last year. This is somewhat belated. If each of you will help keep me informed, we'll try to see that these class notes are more up-to-date.

Since these notes will reach you around the holidays, I'll save stamps by wishing each of you a very merry Christmas and a happy New Year. — **A. L. Bruneau, Jr.**, Secretary, 663 Riverview Dr., Chatham, MA 02633

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Hesitation Waltz. **Robert V. Gould** wrote recently, "Still enjoying the Holland assignment (new vessel traffic management system for Port of Rotterdam). Am torn between staying on and heading back to U.S. for retirement (and inflation and gas shortages)."

Best Foods. **Samuel A. Goldblith**, vice president for resource development at M.I.T., was honored as the distinguished guest at a symposium held at M.I.T. last September to honor his contributions to food science and technology.

Thermal Rise. **Bradley Dewey, Jr.**, president of Thermal Dynamics Corporation since 1968, has been named chairman of the board and chief executive officer.

On Campus. **Bruce Duffett**, class president, reports that **Samuel Goldblith, L. Walter Helmreich, Jr., Louis V. Russoniello**, and **Philip A. Stoddard** and he attended the M.I.T. Alumni Officers' Conference this fall. Walter Helmreich was honored with an award recognizing his outstanding service to M.I.T.'s Educational Council.

Just the Facts, Ma'am. **James Baird** has started his work on the class of 1940's 40th reunion class book, with the welcome help of Maureen Feldman and Sally Bittenbender. Firm decisions have not been made regarding the distribution of the book. Before the final print order is placed the "market" must be determined.

Not So Mini. **Jack Danforth** writes that the Hershey meeting of '40 mates was not held. Too few were able to attend.

Cash Reserves. Still in the black with about $2,000, the class of 1940 has a new treasurer, **Edgar L. Bernard**.

'Tis The Season. Happy holidays and best wishes for the new year. — **Frank A. Yett**, Secretary, 1405 Ptarmigan Dr., Walnut Creek, CA

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Although we received only one item from the Institute for this deadline, we are most fortunate to have received calls and letters from some of you which we can share with all the rest.

Seth H. Washburn has been elected vice president for personnel and public relations of Bell Telephone Laboratories. Seth joined Bell Labs in 1947 and has held positions as development engineer and director and later executive director of the Switching Division at Columbus, Ohio; more recently he was executive director of the Technical Employment, Education, and Salary Administration Division.

In September, Jean, wife of **Mortimer W. Meyer, Jr.**, wrote us that Morty, who "had been disabled for almost 18 years and had suffered also from cancer for almost the last five years," had died on August 25, 1979. We sent our condolences to Jean and asked her to call us collect any time. Their youngest son David, now 24, suffered a brain hemorrhage almost a year ago and has been comatose ever since. We're sure Jean would appreciate hearing from you at 66 Burnett Terrace, Maplewood, N.J. 07040.

We saw Ruth and **Norm Sebell**, Edna and **Stan Warshaw, Andy Corry**, and friends from many other classes at the Alumni Officers' Conference at the end of September. On Saturday morning of the conference the following questions were put to us, and your cooperation in responding to them through us will be greatly appreciated. 1. Why did you come to M.I.T.? 2. Does the need for such an institution still exist today? 3. How should we support what M.I.T. stands for, in addition to continuing financial support? And, speaking of financial support to the Institute: 4. Would you prefer solicitation by mail through the Alumni Association or would you rather be contacted by phone, or in person, by someone in your area for your alumni gift? We need feedback from as many of you as possible.

Ronnie and **Art Peterson** called us recently and then Ronnie called again last week while she was in Cambridge attending activities at Radcliffe helping to establish chapters of Compassionate Friends. The Petersons start their retirement in December visiting their children in West Virginia and Colorado. Then it's back to New York state and their new life work.

Anita and **Les Brindis** called to learn that Newton (Teixiera) is back at work full time following his mid-July heart attack.

Paul Robinson also called to say that he and

son Tim, who had just obtained his "instrument certificate," were flying in a four-place Cessna to Boston the third weekend in October. But we missed them.

Your secretaries spent the Columbus Day weekend with our daughter Eve and her husband in the White Mountains of New Hampshire, visiting them and enjoying the fall foliage, then at its peak.

On October 29 the reunion committee will finally have met to select photographs sent us by **Jim Ruoff** of the 35th reunion in Bermuda. At the rate things are progressing it would appear that the booklet will be available for distribution no later than during the scheduled reunion in 1981 (Fiesta time) in Mexico, under the leadership of **Arturo Morales**, **Joe Aguila** and **Larry LaMadrid**. See you there?

May the holiday season be full of pleasant memories and new lifestyles for some of us, and may the "eighties" be good to us. — **Melissa** and **Newton Teixeira**, Cosecretaries, 92 Webster Park, West Newton, MA 02165

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The Senate of the United States has confirmed the nomination of Major General **Hillman Dickinson** for promotion to lieutenant general and his assignment as director of Command, Control and Communications Systems, of the organization of the Joint Chiefs of Staff. After attending M.I.T., Hillman entered the U.S. Military Academy from which he graduated in 1949. His first assignment was as company commander with the 14th Armored Cavalry in Germany in 1950. Other commands have been the 10th Armored Cavalry and 7th Division in Korea and the 3rd Squadron, 11th Armored Cavalry Regiment in Vietman and the 1st Armored Brigade at Ft. Knox, Ky. During his second tour in Vietnam, Hillman served as senior adviser to the 1st Vietnamese Infantry Division. General Dickinson holds a masters degree in physics from Columbia University and a Ph.D. in physics from Stevens Institute of Technology. Among his published papers are "Report of West Point Study Group," "Sensor Systems," "Systems for Detection of Nuclear Explosions," and "Observations of Flute Type Instability in Plasma," and "Physics of Fluids."

James S. Craig has written to advise he is completing a second major Boston waterfront development, the Union Wharf. Jim also did some work developing and financing a non-profit living facility for the elderly in Concord, Mass. Jim recently joined the Board of the Central Middlesex Mental Health Association to work on community facilities for the mentally ill.

John L. Norton has written again to report he and his wife, Priscilla, are well and enjoying sunny Greenville, S.C. John continues with General Electric Co., managing test operations for large gas turbines. Their daughter, Linda, is married and living in Florida and their son, John, is now States Attorney for Dorchester County in Maryland.

Walter J. Laughlin is production manager of Cordis Corp., Miami, Fla., a manufacturer of pacemakers. . . . **R. T. Galbraith** is now vice president of A.A.A. Technology and Specialties Co. . . . Rear Admiral **Edward F. Welch, Jr.**, who attended M.I.T. until 1944, when he left to enter the Naval Academy, has been appointed the next president of the Naval War College.

Until next time. . . — **Russell K. Dostal**, Secretary, 18837 Palm Circle, Cleveland, OH

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The Alumni Officers' Conference brought out **Parker Symmes**, **Jack Rizika**, **Ed Kane**, **Arnold Judson**, **Bob Hagopian**, **Dan Carnese**, **Ginny Grammer**, and our three Alumni Association officers: **Claude Brenner**, president, **Harl Aldrich**, vice president, and **Dick Knight**, secretary. (Does the association *have* any other offices?)

Ed Kane, with Combustion Engineering, has been to Sidney, Australia, and to Tellawarra to check out the New South Wales Electricity Commission's main power plant. Debriefing was in Maui. Ed is working on pollution control devices — technology to clean up stack gas effluent. His company is big in synthetic fuel programs.

Lee Hanower, according to a reliable source, is living in New Jersey and working in sales for Stone and Webster. He has a son at Harvard (ssss) and a daughter who has graduated from Brandeis.

The Berwick group is expanding, says **Arnold Judson**, with clients in the United States, Canada, and England, and they are looking for more people. (Berwick is probably an equal opportunity employer.)

Claude Brenner, in his role of Alumni Association president, gave what might be considered the keynote speech for his term of office. "M.I.T.'s past is a history of the continuity of change." And for the future, "M.I.T. alumni/ae will provide the leadership for society." I started to take it all down, but it was too well done to keep for just us. I hope it is reported elsewhere at length. One more slightly less profound thought worth repeating: a $100 pledge comes out to less than $2 per week.

Aztec Associates is the name of the new management consulting group recently established in Providence, R.I., by **William Harper**. Aztec, with 12 specialists on call to handle specific problems, provides diversified management aids in administrative development, financial planning, sales programs, public relations, personnel, supervisory training, transportation, international trade, and industrial engineering. (Did I leave out any, Bill?) Through the years, Bill has worked for Chapman Conveyors, Inc., Kalamazoo, Mich., as sales manager, as a staff executive of the Greater Providence Chamber of Commerce, and as administrative assistant to the president of Moran Transportation Industries, Inc.

From the *Wall Street Journal*: "**Jean Tariot**, president of Incoterm Corp., a subsidiary of Honeywell, was named to the additional posts of vice president and general manager of the parent's new Airline and Financial Industries Division."

From **Carol Tucker Seward**: "In July Bill and I spent 10 days in California with **Winnie Bennett Cornlea** in the San Francisco area. While there Winnie took us sightseeing in Yosemite and to the Redwoods as well as to nearby vineyards, the beautiful seacoast, and of course, San Francisco. Later, on a trip to Niagara Falls via Largo, Fla., (the direct route got boring), Bill and I stopped in Columbus, Ohio, to visit with **Hester Stickely Virgin**. Now we're home for a while, ready to convert our garden pumpkins into jack-o-lanterns for our two granchildren. A '48er saw the class notes and asked who was **Ginny Grammer**."

Dear 48er: I don't wonder that you ask. I really was around until March, 1947, but with the war and all, you probably were not. I was not graduated with the class — I finished my B.S. elsewhere — but in 1977 I received an S.M. from M.I.T. and figured that the Institute had finally made an honest woman of me and I could publicly identify with my 1948 class.

The rumor that I am heating my apartment with an electric frying pan is not entirely correct. I also have a clothes dryer and a portable dishwashwer. I have been over to see the solar folk at Claude's establishment about future possibilities, and will be getting one or more interim radiant glass panel(s) for the really cold weather this year. So far, with some below-freezing weather, all the insulation, caulking, and storm windows (not to mention the common walls) have kept the interior temperature above 60.

Awaiting your letters, I remain Ms. **Virginia Grammer**, Secretary, 62 Sullivan St., Charlestown, MA 02129

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As I reported in a past issue of these Class Notes, **Dick Harris** and **Harry Ottobrini** are helping to arrange a mini-reunion for '48 during the 1980 M.I.T. Fiesta in Mexico. Hector Orozco, president of the M.I.T. Club of Mexico City, has written to Dick extending a special invitation to the Class of '48 to come to the Fiesta in Morelia during March 20-25, 1980, and to have a mini-reunion. The M.I.T. Fiesta will be at the Villa Montana Hotel in Morelia. The cost of $595 per person includes air fare from New York, hotel and meals in Morelia, and ground transportation to Morelia which is 200 miles west of Mexico City. Please write or call me if you want to receive the January mailing which is sent to interested alumni. My home telephone is (401) 245-8963 and my business phone is (617) 674-3585.

I recently visited **Roy Evans**. I had not seen Roy since our 5th Reunion at the Mayflower Hotel in Plymouth. Roy and Duane live in Wakefield, Mass., and I spent the night at their home. Roy has an aviary where he raises quail, pheasant, and chuka partridge. His garden covers half an acre and he cultivates flowers and vegetables.

When Roy joined Lam, Inc., they had just been formed to fabricate custom lighting fixtures designed by another M.I.T. graduate. Lam, Inc., pioneers new designs with increased lighting efficiency and provides custom fabrication of fixtures specified by architects. Roy has shared in helping the firm grow to a sales level in the millions. The company recently won a court award protecting a lighting fixture they designed from being copied and sold by Johns Manville. Roy's company has designs that are specified by architects in tennis courts, manufacturing plants and public buildings. Roy has instituted and operated the management systems required in their manufacturing operations.

Roy is a member of the town's budget committee that prepares the municipal budget. Duane works for the fire department. Their sons have graduated from college and are married. Roy has not changed. He came to M.I.T. from New Bedford, Mass.; worked at Walker Memorial; and roomed in the Senior House with Will Freyburger, '47, and later Al Pastuhov, '47.

I was in Wakefield to race in a sailing regatta on Lake Quannapowett. I brought my 110 to the lake and placed third; winning my first trophy in sailing competition.

At the Alumni Officers' Conference in September our class was well represented at meetings of the Educational Council, Alumni Fund, and Club officers. The Alumni Association's highest award for recognition of dedicated service is the Bronze Beaver. This year **Jack Page** received the Bronze Beaver for his dedicated service to M.I.T. Next month's column will report the details of Jack's award. Jack and his wife Imogene still live in Dallas. Jack's consulting business is doing well and he has a number of clients in New Orleans and Houston. They recently enjoyed a tour of Egypt and other Middle Eastern countries. The regular tour guide was a rather dry individual with specialized knowledge, but a guest on the tour was an economist whose academic area was the Middle East and who made numerous interesting presentations during the tour. Jack and Imogene felt their enjoyment of the tour was increased by what they learned during visits to the various sites. They are scheduled for a tour to India.

One of Jack's sons is with Skidmore, Merrill in Chicago and handles projects in Saudia Arabia. Another son, Craig, is completing a five-year program at Vanderbilt. Craig has bought a house that he rents in Dallas as an investment.

Fran and **Jay Salz** have moved from Long Island to Stamford, Conn. Jay is president of Management Systems, Inc. a company that he and his partner formed three years ago. They sell computer systems to other companies. Their son is a sophomore at M.I.T. and their daughter is a senior in high school.

Richard Hall has been appointed vice president and general manager of the Precision Materials Division of Augat, Inc. The three companies in the newly established division will retain their subsidiary status. The new organization is designed to provide more efficient marketing of the products of the subsidiaries and a general improvement in coordination and growth. Augat is based in Attleboro, Mass., and has expanded rapidly from

a solid base in electronic packaging. Richard has been quality assurance director for General Instruments' microelectronics operation. Prior to that he held manufacturing and general management positions with R.C.A. — **Marty Billett**, Secretary, 16 Greenwood Ave., Barrington, RI

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Jack Cook has sent a note that he is moving to Bethlehem — his old home town, I believe. . . . **Austin Marx** is Manager, Corporate Planning and Economics for Hewlett-Packard in Palo Alto, and is keeping involved in Junior Achievement, as Regent of Cogswell College, and as Director of a local boys club. Austin has a son and daughter. . . . **John Alden** is Accreditation Director of the Engineers Council for Professional Development in New York City. . . . **Paul Ostergaard** has, for the second time, been elected President of the National Council of Acoustical Consultants. Ostergaard Associates is in Caldwell, New Jersey. . . . **Ed Somma** sold his business, Grodel, Inc., and, for a year, has been breeding thoroughbreds in Ocala, Florida. . . . **O. F. "Pete" Noss** reports the "oil refining business in Korea to be exciting and challenging." . . . **Roland Jalbert** is finally heard from: he was involved with radiological physics research at the M.I.T. Cancer Clinic, then with healthy physics work at Hanford, followed by teaching physics at the University of Alaska. He's now at Los Alamos Scientific Laboratory, deeply involved in tritium safety. Roland and wife Betty have three boys and a girl. "A very fortunate man am I." . . . **Stanley Fay** is Program Manager with the Control and Flight Dynamics Division of Draper Laboratory. Since last year, he has worked on the relationship between the Space Shuttle's vibration and its attitude controls.

We Forty-Niners have received a most pleasant letter from Jerry Wiesner regarding our Class Gift: "We have benefited immeasurably by the Class of 1949's magnificent commitment. The distinguished Class of 1949 Visiting Professorship, a tribute to your Class's generosity and foresight, plays a vital role in perpetuating the M.I.T. tradition of excellence. There is, we believe, no finer, no more welcome, no more appropriate gift." Kind and appreciated words these! More on the Visiting Professorship in later issues. . . .

Now, for some of the 30th Reunion attendees — the list has been received from **Frank Hulswit**: Mary and **Jack Baker**, **Jack Barriger**, who, incidentally was about to vacation-drive to Alaska in a camper, **Jim Berman**, Dot and **Jim Christopher**, Suzanne and **Russ Cox**, Britt and **Alex D'Arbeloff**, Ginny and **Ron Greene**, Edna and **Jerry Grott**, and Eleanor and **Bill Howlett**. . . . More on these and this in the next issue.

Since this is the holiday issue of *Technology Review* (although written just before editorial deadline in October) let me wish you and yours the best for today, contentment with tomorrow, and happiness forever. — **Paul E. Weamer**, Secretary, 5130 Regent St., Madison, WI 53705

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Karol A. Stark reports a new addition to her family — James W. Stark, born August 6. Might he be a prospect for the class of 2000?

Richard H. Holmberg tells us that his oldest son was married two years ago and is now living in Santa Clara, Calif., his daughter, married in June, is living in Lancaster, Penn.; and his second son is a junior at Penn State. Dick himself is still with International Signal and Control Corp. as vice president and general manager of one of its divisions.

R. Clay Burchell, M.D., director of the Obstetrics and Gynecology Service at Hartford Hospital, was on the faculty of a seminar designed to help health care professionals to identify sex-related problems and to begin the appropriate therapeutic measures. The seminar was held at Middlesex Memorial Hospital in Connecticut on July 19. Dr. Burchell has written and lectured extensively on medical aspects of human sexuality.

We regret to inform you of the death of **Allen E. Bryson**, who was among the 273 persons lost in the American Airlines DC-10 crash outside O'Hare Airport in Chicago on May 25. He was employed for the last 30 years by the Atlantic-Richfield Co. in Los Angeles and was en route to his home in Arcadia, Calif. He leaves his wife, Dorothy, and four daughters, all of Arcadia.

William N. Johnston was elected chairman of the board and president of the American Bureau of Shipping at the annual meeting of its board of managers held in New York on April 17. In 28 years of service he has represented the Bureau in field and administrative posts in dozens of countries. He and his family managed to absorb the cultures and customs of other countries without losing their own, and they all have fond memories of London, Liverpool, and St. Nazaire. Mr. Johnston has two hobbies — his family and his work — and is perfectly content with his life just the way it is.

Bill Murphy, your chairman for our 30th reunion, has an active committee working, and you will be hearing from him soon. Don't forget to reserve the dates of June 5, 6, 7, and 8 for this important event. — **John T. McKenna, Jr.**, Secretary, One Emerson Place, Boston, MA 02114

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Greetings fellow classmates. We finally have some more news from some of our class personalities. We have both good and bad news — first the good news.

John Dowds has been appointed a trustee of Thomas Jefferson University in Philadelphia. John resides in Oklahoma City and is president and owner of no other than Dowds and Co., specializing in the exploration and development of oil and gas resources. John has been particularly successful in developing probability/statistical computer techniques for analyzing data to reduce petroleum exploration risks. Congratulations John, and let us know where the next big oil field with no risk is located.

Frank Heart of Lexington, Mass., has been elected a senior vice president of Bolt, Barenek, and Newman. Frank has been with BBN since 1966 and was divisional vice president in 1968 and corporation vice president in 1973. Frank has primarily been involved in the management and technical areas of systems development in computer communications. He has also been very active in several professional societies as well as a consultant to H.E.W. Best of luck, Frank, on your new position. Keep in touch.

Received a note from **Karl den Tex**. He writes a most interesting and profound statement: "Environmental economics — fuel savings to date on moped $45, hospital bills $6700 plus eight broken ribs. You can't win." He also adds that one more trip to St. Martin and they may say good-bye to Minnesota forever. Of course since I am in California, I can't see saying hello to Minnesota, except that they always beat the Rams — but then everyone is beating them this year.

I am sure all the members of the class of '51 remember **Al Boltax**. Received a note from Al that he just returned from a most exciting international meeting — would you believe on the subject of "Irradiation Behavior of Metallic Materials for Fast-Reactor Core Components." This was held on the beautiful island of Corsica, where Napoleon was born. I think the group of scientists would have been put to sleep if not for the large number of topless beaches on the island. I know Al wasn't referring to the men. Good to hear from you Al — keep us informed of what's new in Madison, Pa.

Bill Gable has left Xerox Corp. and joined Computor Sciences Corp. as vice president for business planning. Bill and Hattie also just celebrated their 30th wedding anniversary. Let's all wish them good health, long life, and at least another 30 years. . . . Remember **Fred Bumpus**, one of our class officers? Well, Fred was just elected president and chief operating officer of Arkwright-Boston Manufacturers Mutual Insurance Co. Fred, as your first piece of business, how about shortening the name of the Company — takes too long to type. Fred was also named a director. How many of you knew Fred was also an attorney who graduated from Fordham University Law School? Good to hear from you Fred. Also received a note from an old buddy of mine from Strong Vincent High School in Erie, Pa., **Roger Christman**. Roger writes that his second offspring graduated from M.I.T. His daughter Diana was vice president of the class of '78 and received her M.S. from the Sloan School in 1979. Roger, time sure has flown by since the days we left Erie. Lets hear more from you.

Some of the bad news: I regret announcing the passing of our classmates **Julius Leonhard** of Maynard, Mass. We send our condolences to his wife Gertrude and children. I am also sorry to report the passing of **Pedro E. Moran** in December of last year.

Back to good news. Your chief class secretary **Sam Rubinovitz** has been elected vice president for electron devices of E.G.&G. of Wellesley. Sam joined the company in 1963 after obtaining a master's degree in economics from M.I.T. All of us underling secretaries are proud of our boss. Congratulations.

As a final tidbit, yours truly has had a complete change of life — no, not a sex operation — a socio-economic change. I sold my printing business, sold my house, and am thinking about selling some of my kids. Shirley and I are leaving for a nice long vacation in Israel and Greece, and then we go back to Pasadena to start job and house hunting. I hope all of you who read this will send us information concerning your happenings and whereabouts. — **Mark Franklin**, Assistant Secretary, 291 S. Euclid, Apt. PH2, Pasadena, CA; **Sam Rubinovitz**, Secretary, 3 Bowser Rd., Lexington, MA 02173; Assistant Secretaries: **Gregor J. Gentleman, Jr.**, Swanson Gentleman, Inc., 818 SW. 9th St., Des Moines, IA 50309; **Paul H. Grady**, 16 Brook Ln., Westport, CT 06880

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Usually your secretary complains bitterly about a shortage of news to put into this column. This month the exact opposite problem presents itself. Class members have been more than usually active and have been very good in communicating all of their activities, some of which are perhaps a little different from the usual run-of-the-mill of promotions and so forth.

Most noteworthy among these news items comes from our class president, **Arnie Kramer** and his wife Roz. They announced, August 15, that they have adopted a new son by the name of Alexander Ross, age 7½ months. Usually the birth of a son is a matter of months from start to finish. In this case it was a matter of years. Both Roz and Arnie have determination beyond measure. We all give our wishes for the best of good fortune to Roz, Arnie and Alexander. They will be at home at 381 Peakham Road in Sudbury, MA. . . . **Stephen Spacil** was a long time M.I.T. student, a resident of the Baker house, and the earner of a Ph.D. from the Department of Metallurgy. Since 1959 he has been at G.E.'s Schenectady, N.Y. facility. Recently Steve has been appointed the General Electric Research and Development Center Scientific Representative for Asia. Steve writes that he will be located in Tokyo for at least three years. His territory will be the Far East from Japan to Singapore plus China. That promises to be an exciting job and a quite different career from his past years with G.E., which have not been unexceptional. Steve has conducted research in chemical processing of metals, heat treatment and high-temperature physical chemistry, and electrochemistry. In those years since 1959 he has authored some 15 technical publications and holds 19 patents, a remarkable achievement. In addition he is a Fellow of the American Society of Metals and is chairman of Electrothermics and Metallurgy Division of the Electrochemical Society.

Dr. **Brenton R. Groves** has recently been appointed Managing Director of ELMECO Pty. Ltd., a company owned jointly by B. R. Groves and

Associates of Melbourne and Electric Measurement and Control, Ltd. of Auckland, New Zealand. The new company will be the Australian representative of the U.S. Analogic line of digital meters, data conversion equipment, and NZ EMC, Ltd. line of beltweighers, automatic scalers, and control equipment. Brent writes that he is "the world's smallest multinational." . . . Captain **Charles J. Mathews** notes that he has recently retired from the Navy as Captain in the Civil Engineer's Corps and has joined Fluor Corporation of Irvine, Calif., as a construction contract administrator. Mr. Mathews is currently located in Saudi Arabia constructing a natural gas liquification plant for Aramco. The plant is valued at 1 billion US dollars. . . . Battelle Columbus Laboratories has announced that **Edward S. Lipinsky**, internationally recognized as an expert in developing new energy resources from biomass, has been named a senior research leader in the Resource Management and Economic Analysis Department at Battelle's Columbus Division. Batelle-Columbus has only seven other persons in this position. Ed will supervise and conduct technical and economic research in the use of solar energy to produce fuels and materials from plants and crops while still retaining much of their food value. During 19 years at Battelle, Ed has been active in developing efficient uses of resources. Most recently, he has been studying ways to integrate the production of motor fuels, food, and construction materials from sweet sorghum, corn, and other crops. Ed has been the author of more than 30 technical publications and is co-editor of a new handbook of biosolar resources.

The founder and president of Radiation Sterilizers, Inc. a recently formed company is **Allan Chin**. Al's company is currently building in southern Calif. the largest gamma facility in the U.S. for sterilizing plastic disposable medical devices. The facility is estimated to be complete by July 15. Allan has been in Palo Alto 13 years. His daughter is a 1979 graduate of Stanford and his son is in M.I.T.'s class of 1981. . . . **Robert H. Norton**, C.L.U. writes that he has established insurance offices at his home to serve his growing corporate and business clientele better. . . . The new senior vice president of Heidrick and Struggles (the international executive search firm), is **James I. Stockwell**. Jim has been with the firm in the Boston office since 1974. . . . **John F. Maxwell** tells us that he has moved from the East Coast to the West Coast and has switched "from business to the business of education" at the University of Calif. extension, Berkeley, where he is in the Business and Management Department. He has also been doing some hiking in the Sierras. . . . **Sandy M. Isaacs** says that he has left Interbank after three years commuting to N.Y.C. where he was trying to improve the Mastercharge world-wide networks of credit card computers. He is now home again at Mass. General Hospital, which is a change of pace. Sandy writes that he is "glad to be doing something socially useful in a great atmosphere with good support for new systems efforts." Sandy's daughter has finished her first year at Williams, and his son is starting at Dartmouth this fall.

The Society of Exploration Geophysicists has announced that **Milo M. Backus**, the Wallace A. Pratt Professor of Geophysics at the University of Texas in Austin, has been elected president of the society, a scientific organization with over 12,000 members throughout the world. Professor Backus has been with the University of Texas Department of Geological Sciences since September 1975 and is a prolific author of papers on geophysics. He joined the University of Texas after spending 18 years with Geophysical Service, Inc. in Dallas. . . . **Charles J. Carter** of Bedford, MA has been named department head of Tactical Command systems at the M.I.T.R.E. Corp. in Bedford. In his new position he will be responsible for assistance to the Air Force in the systems acquisition process for tactical command systems. In addition, he will be responsible for M.I.T.R.E.'s work for the State Department in designing and implementing systems for issuing immigrant and non-immigrant visas. Charles has been in management at M.I.T.R.E. since 1968 having been with the corporation since its founding in 1959. Before that he was at M.I.T.'s Lincoln Laboratory. He lives in Bedford with his wife, the former Irma Crocetti, and his four children William, James, Mary Ellen and John. He is very active in Bedford, being president of the Wedgewood Club and a member of the School Committee's Financial Reporting Task Force. He has also been involved in the community youth activities. He is a certified A.A.U. Swimming Official and a Boy Scout committeeman. . . . On August 10, 1977, Dr. **Aristotle Scoledes** and Barbara Lynn Shapray were married at Emory University in Atlanta, Georgia. The new Mrs. Scoledes is a graduate of Vassar College. Dr. Scoledes is presently a consultant on energy.

It is with sorrow that we announce the death of **Robert William Stuart, Jr.** of Woodmoor Drive, Bedford, MA, an electronics engineer with Dynamic Research Corp. of Wilmington. Mr. Stuart died on August 21, 1979 at Massachusetts General Hospital. He was born in Binghamton, N.Y. and he had resided in Bedford for the past 13 years. He had received bachelor's and master's degrees in electrical engineering from M.I.T. and had been an electronics engineer with Dynamic Research Corp. since 1962. He had perfected many U.S. and foreign patents in ship and submarine navigation equipment with Dynamic Research. He was a member of the Institute of Electronic and Electrical Engineers and a veteran of World War II. Mr. Stuart leaves his wife, Diane, two sons, Matthew Kenneth and Adam Winston both of Bedford; and his father, Robert W. Stuart of Binghamton, N.Y. — **Arthur S. Turner**, Secretary, 175 Lowell St., Carlisle, MA 01741; **Richard F. Lacey**, Assistant Secretary, 2340 Cowper St., Palo Alto, CA 94301

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We want to start off this column extending to our fellow classmate, Dr. **Paul Gray**, congratulations on his election by the M.I.T. Corporation as the 14th President of the Institute. Paul, as many of you know, has been associated with M.I.T. ever since graduating with us in 1954 except for two years of military service. He has served in many positions during his years at M.I.T., most recently as Chancellor of the Institute. Paul received an S.M. in 1955 and an Sc.D. in 1960, all in electrical engineering. He is an authority on electronics circuits and semiconductor devices. He is a member of the National Academy of Engineering, a fellow of the Institute of Electrical and Electronics Engineers, and is also a fellow of the American Academy of Arts and Sciences. He is a member of many professional societies as well as a director of a number of companies. We certainly want to wish Paul success in this most prodigious position.

We have some additional items to mention to you with regard to our 25th Reunion held last June. **Bob Warshawer** has managed to locate his notes of the awards he presented to various members of the class on the last evening of the Reunion and has promised to have them in legible form for our February issue. Bob also reports that he has a record of all pictures taken at the Reunion by number and anyone interested in any of these pictures can contact him at his home at 11 Tower Road in Lexington, Mass. 02173. Bob also has some souvenir rings left for anyone interested. Due to the heavy demands for these rings at the Reunion, Bob had to reorder additional ones.

We have received some information of some of our fellow classmates that we thought you would be interested in. **Martin Cohen** from Course IV reports that he and his wife Arline were not able to attend our Reunion due to a previous commitment. Martin was invested in early June into a Fellowship in the American Institute of Architects. He and his wife were then off to Wisconsin for a dedication of a new hospital his firm just completed. He has been working for Skidmore, Owings, and Merrill of New York for the past 23 years and is now an associate partner. . . . **Bob Mason** from Course VIII authored a newspaper article in July advocating a stronger effort toward the use of nuclear fusion as a means of producing electrical power. Bob went on to say in his article that instead of requiring a hugh mass of radioactive material for viability, a controlled fusion process feeds on the element hydrogen extracted from sea water. It is fed in a small mass to an as yet undeveloped "furnace" where fusion and energy release takes place. Since no large radioactive mass is present, it cannot "run away" and self-destruct. The by-products are not devastatingly harmful as from the fission process, and no waste disposal will be needed. Vast quantities of power could then be generated which can be used to create synthetic fuels, for example hydrogen gas for autos, home, aircraft, tractors, and all the various uses to which we now put petroleum products. Bob is a physicist currently engaged in instrument design and manufacturing. Since nuclear power has become a very controversial item, perhaps we will hear more on this subject from some of you.

We received a short note from **Paul Pollinger** indicating he had hoped to make the Reunion, but it turned out he was unable to. He reported that since leaving M.I.T. he has served as a Navy aviator and participated in the startup of several venture companies. In recent years he restored a commercial building in Washington, D.C. that has led to the rejuvenation of a several-block area in downtown. In addition, with a knowledgeable art partner, he has backed the startup of an art gallery and has received considerable critical acclaim. He further comments that his reflections on M.I.T. over the last 25 years have led him to the opinion that for all its potential, M.I.T. of the 1950's has not yet fulfilled its promise to society. Unless one believes that scientific creativity peaks at age 30, it is not too late. Anyone out there care to comment on Paul's thoughts on that one?

An Alumni Officers' Conference was held on September 28 and 29 at M.I.T. One of our classmates, **John Blair**, was chairman of the Alumni Officers' Conference Committee. Other classmates present for the conference were **Art Haines**, **George Schwenk**, **Bob Warshawer**, **Dave Wiesen**, **Dean Jacoby**, **Paul Gray**, **William Combs**, **Frank Ahearn**, and **Ron Kurtz**. Doc Edgerton entertained the attendees at the opening banquet of the conference. On Saturday, September 29, there was a presentation of Alumni Awards, luncheon with living groups, followed by a short series of presentations by distinguished faculty members.

In preparation for this column your Class Secretaries held a meeting on Wednesday, October 17, at which time we decided to do a profile on our Class Officers so that you can find out what they are really like even though it is too late now. It came to our attention that we do not have the address of our new President, **Larry Holmes**, although we do know he has recently assumed a new position at Yale University. Larry, just in case we do not get your new address before the next issue, please let us know of your whereabouts so we can start off telling everyone what you have been doing for the last 25 years. We also intend to write to other members of the class whom we have not seen or heard from in a long time to see if we can't renew some old friendships and keep our column interesting.

Even though it is now October 22 and the temperature in Boston today is in the 80's, we want to wish everyone the best of holidays and a happy New Year since our next issue won't be out until February 1980. — **William Combs**, 120 West Newton St., Boston, MA 02118; **John Kiley**, 7 Kensington Rd., Woburn, MA 01801; **Louis E. Mahoney**, 14 Danby Rd., Stoneham, MA 02180; Dr. **Dominick Sama**, Chestnut Hill Rd., Groton, MA 01450

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You folks haven't been very informative recently. Hopefully, this is but the lull before the storm of news accompanying your '79 Alumni Fund contributions and leading up to the reunion in June.

In any event, we can report the following widely scattered matters:

Barry Benepe (architecture) has actively promoted a "Greenmarket" project in New York City over the past four years. The Greenmarket program has enabled a number of participating farmers to offer produce at local sites throughout the city at prices competitive with the local supermarkets. We understand that Greenmarket first opened in 1976 in three Manhattan locations with five participating farmers, but has now expanded to eight different sites with more than two dozen participating growers. The *New York Times* has termed Barry's brainchild "a New York institution" and he has received awards this year in connection with the project from the Municipal Art Society and the New York Chapter of the American Institute of Architects.

From the farms in the city we travel briefly to the quarry in the country. Thus, we hear from **Dan Kiser** (Course II) that he is currently the owner/operator of a limestone quarry in Drumright, Oklahoma. If Dan can't get to Cambridge in June, I'm sure that he will be pleased to receive any classmate visitors passing through Drumright. . . . We have learned that **Charles J. Henry** (Course XIII) was named the president and chief operating officer of the Chicago Board Options Exchange last summer. The brief explanatory item indicated that Mr. Henry is an expert in data communications, and previously directed computer and electronic systems training for the Air Force. . . . We also must discharge the sad duty of advising you that **Bill Antoine** (Course XX) was killed in an automobile accident near his home in Pasadena, California last June. Bill's widow Sheila wrote of his passing and of his attachment to M.I.T. and our class. Those who knew Bill and Sheila may wish to look her up in Pasadena.

Finally, **Gene Davis**, **Philip Molten**, **Fred Morgenthaler**, **Harry Schreiber**, **Denny Shapiro** and your western correspondent attended the Alumni Officers' Conference in Cambridge last September. Phil, who operates a photography studio in Tiburon, Calif., received an award for his work in connection with interviewing M.I.T. applicants for the Educational Council. Phil also reported his recent success, as vice president of the Belvedere-Tiburon Landmarks Society, in obtaining a grant from the National Trust for Historic Preservation to save and restore a valuable marine relic — the "China Cabin." The "Cabin" had been the social hall aboard the world's largest wooden passenger ship, the nineteenth century paddlewheel steamer "China." Again, on both counts our congratulations, Phil!

It was good to see the others again, and to hear of Gene's recent accomplishments in the courtroom, Harry's continued globegirdling activities, and the success of Denny's new medical electronics venture. 'Twas but a preview of renewed acquaintances which we may all share at the reunion in June. In this connection, apart from promising an increased flow of information in the next few months our prexy Dr. Morganthaler (Fred, that is) indicated that as of our September conversation over 100 classmates had indicated that they hoped to attend the 25th reunion.

One last suggestion — in order to maximize the turnout next June, we suggest you contact old friends, roommates, fraternity brothers or the like in order to encourage their attendance in Cambridge. Without wishing to dispense either corn or platitudes, the occasion is unique with respect to our relationship to M.I.T. and to one another — and the reunion should provide a good time for one and all. To that end, let's get out the troops! See you in Cambridge. — Co-Secretaries **Marc S. Gross**, 341 South Bedford Dr., Beverly Hills, CA 90212; and **Allan C. Schell**, 19 Wedgemere Ave., Winchester, MA 01890.

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Larry Blodgett was named manager of the Chesebrough-Ponds plant in Clinton, Conn. He had been engineering group manager since joining C-P in 1974 following positions with Ciba Products, Acme Cotton Products, and Chemical Dynamics. Larry took his M.S. in Chemical Engineering at Stevens. He and Carol live in Killingworth, Conn., with their three sons.

Gene Amazon has been developing computer applications for the Swiss bankers in Basel and Geneva — even the gnomes are being automated by one of our classmates! Gene is with D.S.T. Computer Services in Geneva. On the other side of the world, **Jose Reyes** is chairman of a shipping firm, Reyes and Lim Co., in the Philippines. His four children are at Harvard, Duke, and Groton; his wife Angelita is a dermatologist in Manila. . . . **Chris Van Peski** is with the Electromask Division of T.R.E. in Woodland Hills, Calif., supplying equipment to the semiconductor industry.

Dave McBridge is the new director of the Center for Industrial Development at Youngstown (Ohio) State University. Dave completed his Sc.D. in metallurgy at M.I.T., and has been director of planning at both Jones and Laughlin and Youngstown Sheet and Tube Co. . . . **Kreon Cyros** is director of Facilities Management Systems at M.I.T., and has developed new procedures for tracking equipment for government grants and cost accounting. . . . Dr. **Rosemarie Wahl Synek** heads the Biology Department at St Mary's University in San Antonio, Tex. — Cosecretaries **Bruce Bredehoft**, 7100 Lanham La., Edina, MI 55435; **Warren Briggs**, 33 Bancroft Rd., Wellesley, MA 02181

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Although the exciting eighties are now upon us, it seems like shades of the fifties in some respects. At any rate, good wishes for the holiday season!

If the snow has started to fly by the time you read this, maybe the image of one of our classmates, already retired to a proverbial tropical island, will brighten your day. I received a card from **Roy Thorpe** telling us that he has "retired from active participation in business after hiring an executive vice president to take over. I moved to a picturesque island called Spanish Wells in the Bahamas, lying about 40 miles east of Nassau. I'm eating fresh fish and lobster every day and growing corn, tomatoes, and other vegetables on ten acres overlooking the Atlantic Ocean."

Everyone seems to be moving about this year — it must be the 24-year itch! Elaine and **Jack Kesten** relocated from New York to Saint Louis where he has joined Hospital Building and Equipment Corp. as project architect. . . . **Richard Nyder**, his wife Penny and their two children have relocated in Everett, Wash., where they have a house in the woods overlooking Puget Sound. He has taken a position with John Fluke Manufacturing Co. as a senior product planner doing long range product and market studies for the precision instrumentation unit.

Congratulations go to **Vic Klemas**, who has just been promoted to full professor in marine studies at the University of Delaware. At this moment, Vic has run up his list of published papers to over 50, and he is serving on the editorial boards of two technical journals. . . . **James Perrin** has been named a senior research leader at Battelle's Columbus laboratories. Jim is a specialist in nuclear materials and has recently been appointed vice-chairman of the 1980 A.S.T.M. International Symposium on the Effects of Radiation on Materials. Since joining Battelle in 1966, Jim has managed a variety of projects ranging from nuclear pressure vessel surveillance to advanced materials for components and structures for reactors.

While in Toledo recently, I had lunch with **Paul Rothschild**, who is at Owens-Illinois. Paul was recently promoted to the position of business development manager for the worldwide business development organization of O-I. He will be responsible for exploring development opportunities for the firm's plastic and closure products. At the same time, he was appointed a vice president of the corporate staff. . . . **John Boynton** writes of the latest in his adventures: "Just received a master of social work degree, making me one of the few practicing consulting engineers also practicing clinical psychotherapy. I am also about to embark on building at home a twoplace, twin-engine aircraft of my own design. I hope there is gas to burn in it when it is done!"

That's it for this month. Everybody be nice to each other, and we'll meet again in the next decade. — **Mike Brose**, Secretary, 59 Rutland Sq., Boston, MA 02118

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It has been a quiet summer and fall in the class notes department. But recently the mail has been bringing a little bit of news from out there. **Roy Breon** wrote that he is "still manager of marketing for Harris Corp. in Ft. Walton Beach, Fla. Daughter Christiana will attend the University of Rochester as a pre-med freshman this fall. She plans to specialize in surgery." **George Harrison** has moved up to assistant vice president at Merrill Lynch where he has been since 1972. Before that, George worked at Boeing in Seattle and (reading between the lines) switched fields when Boeing's business was at an ebb in the early '70s. **William Anderson** is an air operations officer at Lakenheath R.A.F. station in England with the 48th tactical fighter wing. **Richard Berendzen** will become the president of American University in Washington, D.C. in early January. Richard has been provost and professor of physics there since 1976. Before that he was dean of the College of Arts and Sciences at A.U. He really has had an outstanding career, having at one time headed the Boston University Astronomy department and having taught at Harvard along the way. Congratulations! That's what has come up in the mail recently. Keep writing so I can keep writing! — **Andrew Braun**, 464 Heath St., Chestnut Hill, MA 02167

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This is my first column as your new Class Secretary but the feeling is a little like being Secretary of the Class of 1862: I have received no news items to report. Please help out by sending me a note telling where you are and what you are doing or scribble a short message on the back of your Alumni Fund contribution envelope.

Here in Champaign-Urbana at the University of Illinois I am aware of two other members of our class: **Joe Crowley**, recently promoted to Full Professor of Electrical Engineering and **Harold Benzinger**, Associate Professor Mathematics. I am currently an Associate Professor in Aeronautical and Astronautical Engineering. My wife Laurel, Wellesley Class of 1962, leads a more exciting life as a local politician. She was elected Champaign County Auditor in 1976 and is gearing up for another campaign.

Last summer we and our three daughters drove to Boston and stayed with Joanne and **Don Fraser** and their two children. Don is Director of the Control and Flight Dynamics Division at the C. S. Draper Laboratory in Cambridge and enjoys flying his airplane.

Special thanks go to **Jerry Katell** for his conscientious job as Class Secretary for 17 years. I advised him that if he stayed on for three more years he might receive a solid gold wrist sundial, but he declined. — **John E. Prussing**, Secretary, 2106 Grange Dr., Urbana, IL 61801

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Ho, ho, ho. Merry Christmas, Happy New Year and all that. Here's a bit of last summer's news to warm up your winter days. . . . **Steven Rudnick** is the president of S.M.R. Electronics, Inc., a consulting and manufacturing organization. . . . **Mike Pearlman** is on sabbatical leave from the Smithsonian Astrophysical Observatory for the year 1979-80. He is in the M.I.T. Sloan Fellows Program for the year. . . . **Robert Jesurum** is director of research and development for National C.S.S. He is engaged in the development of future software and hardware systems, especially opera-

ting systems to support distributed data base applications. . . . **Edgar C. Rust, III**, writes that he has established the firm of Rust and Weinstein, Inc., in San Francisco. Edgar's company is involved in social, economic, and environmental planning. Major projects to date have included studies of LNG terminal sitting, and crude oil transportation facilities.

Glen Books reports that after several years in New York, he and his family have moved back to the Boston area (Andover.) Glen is now associated with the patent law firm of Weingarten, Maxham, and Schurgin in Boston. . . . **Jack Solomon** informs us that he has had two patents granted. His carburizing and sintering processes are being accepted by the heat treating industry. About 30 customers are already using these techniques. Jack and Jan's daughter, Sheri, is at the University of California at Santa Barbara, studying sociology. The other two girls in the family, Lisa, five, and Susan, two, are at home in Rye, N.Y., with mom and dad.

Finally, **Steve Evans** wrote to say that he is still at the Rocketdyne Division of Rockwell International. His current position is business development manager for high energy lasers. Steve has seen **Paul Berger** several times this year, the first classmate he has met in a business relationship. Paul is with Lincoln Labs on assignment at White Sands. As with many of us resettled Easterners, Steve says he still enjoys the California climate and has no regrets about leaving the cold Boston winters.

Once again, Season's Greetings, and more news next month. — **Mike Bertin**, Secretary, 18022 Gillman St., Irvine, CA 92715

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Greetings '64. We're still finishing up reporting on all those class heroes we corralled at our last reunion.

Steve Glassman, our new class agent, is still single and lives in New York. He was assistant U.S. attorney in New York from 1971 to 1976. Steve is presently a partner in the New York law firm of Kaye, Scholer, Fierman, Hays, and Handler located at 425 Park Ave. An expert skier and an average tennis player, Steve works hard but relishes his leisure time.

Another class hero is **Arthur R. Best**. Art and Sharon Brudnicki were married in August 1976 and are now the proud parents of a 17-month-old boy, Arthur R. Best, Jr. Art is in the automotive parts business covering the mid-Atlantic states. He no longer does any fencing but has become an expert skier, for the Bests spend three weeks a year in Vail, Colo.

A third class hero is **Dave Fahrland**. Dave married Lu Eldridge Seiler in Boston in June 1977. He now sells commercial minicomputer systems for Hewlett Packard in Fairfield County, Conn. Lu, a business school graduate from up the river, provides Dave with healthy competition in marketing endeavors.

Last, we have received a news release from the U. S. Department of Transportation about **Robert W. Wisleder**. Bob has been appointed executive assistant to the director of the Transportation Systems Center of the U.S. Department of Transportation in Cambridge, Mass. He is married to the former Jane Fallon of Milton, Mass., and they are the proud parents of three children. The Wisleders reside in Hingham.

Without Alumni Fund envelopes notes we would have many a month with no news of our fellow classmates. Thanks to the following for remembering M.I.T. and the class of '64!

Major **Joseph Boling** is still living in Heidelberg, Germany where he works at the U.S. Army's Command and Control Data Processing Center. Joe should be back stateside by the time you read this column. He has co-authored a book entitled *World War II Military Currency*, a comprehensive history and catalog of worldwide World War II issues.

The operations manager of advanced night vision/phototube operation of Varian's Light Sensing and Emitting Division is **John Endriz**. . . . Since 1975 **Jim Lerner** has been working at the California Energy Commission, where he initiated and developed a wind energy program with the goal of supplying 1 per cent of California's electricity by 1987 and 10 per cent by the year 2000. . . . **Patricia Page Wilcox** has been teaching computer science at Indiana University of Pennsylvania. In her spare time she is finishing up the course work for a master's in geography. Her thesis is on the automated cartography of caves.

Keep those envelopes coming! The funds are important if M.I.T. is to continue as a leader in the academic world, and the notes are invaluable to this column. (And thanks to Marlene for this column.) — **Steve Schlosser**, Secretary, 11129 Deborah Dr., Potomac, MD 20854

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This month's hero is **David Kettner**, who is now back from a four-year stint in the Marshall Islands. Dave was working at the Kiernan Reentry Measurements Site, finishing his tour as associate site manager. A second son, Marshall, was born last spring, joining five-year-old Raymond. The Kettners were able to travel in Micronesia, Japan, and Hawaii, and David learned how to scuba-dive. Dave passed on word that **Matt Mleziva** is chairman of the Acton Finance Committee.

In another bit of long-distance info, **Bill Brody** wrote from Stanford to tell us that **Dick Tsien** has been promoted to full professor of physiology at the Yale University School of Medicine.

From the clipping service we learn that **Aaron Goldberg** is still with GTE Sylvania; he gave a talk on high-quality voice transmission at 9,600 and 16,000 bps at a recent I.E.E.E. meeting. **Michael Foster**, associate professor of Aero and Astro at Ohio State, is currently serving as a visiting associate professor at Lehigh.

That is it for this month. We need more class heros! Remember our 15th — first week of June. Hope to have more specifics by next issue. — **Edward P. Hoffer**, M.D., Secretary, 12 Upland Rd., Wellesley, MA 02181

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George Stiny and **James Gips** are the authors of a new book, *Algorithmic Aesthetics: Computer Models for Criticism and Design in the Arts*. . . . **David Garbin** has left I.B.M. Federal Systems Division and is now a communications analyst with Satellite Business Systems. . . . **James Rumbaugh** has been appointed manager of the Mathematics and Software Engineering Program at the General Electric Research and Development Center in Schenectady, N.Y. . . . **Daniel Hester** writes that he is enjoying his teaching job at the high school in the regional school district of Hiram, Maine. This year he is chairman of the science department and advisor for both the math and hiking clubs — **Jim Swanson**, Secretary, 878 Hoffman Ter., Los Altos, CA 94022

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Since last month I talked with the folks at *Technology Review* and the Alumni Fund, and they cooperated in a new system which forwards notes to me four to six weeks sooner than I reported last month. Which means that over a two-month period only three of you wrote! So if you don't want to hear more about what I'm doing than you ever cared to know: WRITE.

Joseph L. Veranth was just appointed vice president for engineering for the Bose Corporation, where he has been working since 1970. When we were undergraduates Bose made the best loudspeakers in the world. Do they still allow discounts to M.I.T. people?

Last year **James P. Kornberg** and wife Sally were blessed with their second daughter, Jamie Altair. On November 1 Jim was appointed Director of Occupational Medicine at the Boulder Medical Center, Boulder, Colorado. He will be concentrating on the health effects of new energy technologies, especially coal gasification and liquefaction.

Finally, **Gary Carpenter** is in the second year of an allergy-immunology Fellowship, but he neglected to mention just where.

I've been phoning around to come up with more information, and can now report that **Tom Najarian** has had his book, *Set For Life? The Insurance Rip-Off and How To Beat It*, published by his wife Sina's publishing company, SMDN Publishing. I read the manuscript and found it a concise, informative book on the insurance game and how to save money when getting insurance. It's currently distributed to bookstores in the Boston/Cambridge area with wider distribution in the works.

As for myself, I am starting to follow up on some of the contacts I made when in England last month. Everything takes so much longer when you have to deal overseas. Now remember, if you don't want to hear about my publishing business, write — **Robert K. Wiener**, Secretary, Box 27, M.I.T. Branch, Cambridge, MA 02139

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It is my sad duty to report the death of our classmate **Prakash D. Dahanukar**, who died in an air crash near Bombay, India. His sister wrote that at the time of his demise, Prakash had started his own enterprise, the main activity of which was the production of 8-hydroxyquinoline used in an anti-dysentery drug, 4-7 dichloroquinoline as an intermediate in antimalarial drugs, and chloroquine diphosphate, a well-known antimalarial drug. The entire project was developed using technical know-how developed indigenously in India by himself and his colleagues. Prakash was at M.I.T. from 1970 to 1973, completing a bachelor's degree in mechanical engineering and a master's degree at the Sloan School of Management. "He had nothing but praise for his rewarding years at the Institute, which gave him maturity and all-round expertise in the business world. He always felt the superb academic foundation and training he received in M.I.T. enabled him to begin his own company. He also took an wrote.

Charles E. Blair writes that he is teaching operations research in the Business Department at the University of Illinois. His bridge habit is more or less paying for his backgammon habit. . . . **Al Solish** graduated from medical school in May and following a year's internship will be doing his residency in opthalmology at the Jules Skin and Eye Institute at U.C.L.A. His wife, Margaret Fresking ('72), received her Ph.D. (course VIII) a year ago and is at Bell Labs. . . . **Timothy M. Bradley** is an associate of Charles J. W. Chamberland, A.I.A., Inc., of Honolulu, running the branch office of the firm on the island of Kauai. In his spare time he works on finishing his own home and supervising construction of his parents' home, both of which he designed.

Scott Ramos writes: "Joan and I just got back from a short stay in Brazil, where we adopted a beautiful little girl." . . . From **Jeffrey L. Cooper**: "I have just returned from the Orient where my acoustical consulting firm has been engaged to design new recording studios for Polygram Records in Singapore. Back in California, the firm is in the process of completing a computerized film mixing facility for Fantasy Films (*One Flew Over the Cuckoo's Nest*) as well as studios for the Christian Broadcasting Network. By the way, I am seeing a lot of Shelley Bernstein ('73), who has also settled in Los Angeles and works in management at the Kaiser health care organization." . . . Captain **Eric Kraemer** writes: "I am enjoying the German life with the First Infantry Division Forward where I am the plans and production officer for Division G2. We're located in a small city called Goppingen in southern Germany, a beautiful area and one well located for winter ski trips.

Lucy and I have finally moved into our house after one year of construction. Season's greetings, and a Happy New Year! — **Hal Moorman**, P.O. Box 1808, Brenham, TX 77833

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Peter B. Hutzel, who is living in Brooklyn has been appointed assistant vice president of Johnson and Higgins, an international insurance brokerage, average adjusting, and employee benefit consulting firm in New York City. . . . **Dave deBronkart**, living in Arlington, has been promoted to product manager of the AdVantage system at Compugraphic Corp. in Wilmington, Mass.

Rick Bradley writes, "Since graduating I have spent one year on a cattle ranch in central Oregon, another as a landscape laborer in Denver, another as a math grad student at U.C.S.D. (Ph.D. in 1978) and this past year as an assistant professor of mathematical statistics at Columbia. My experiences in New York City have included the usual sightseeing and visits to museums and concerts, along with being mugged, having books stolen from my office, and an (unsuccessful) attempt by two guys to con me into guarding a big roll of money for a few days. I also saw **Jim Knauer** who was involved in some experiments in high energy particle physics at Brookhaven Lab."

Al Kirkpatrick, back as a graduate student, is a tutor in Baker. . . . **Paul Levy** resigned as commissioner of the Massachusetts Department of Public Utilities following the election of the new governor and he is currently working for the state of Arkansas. He was a witness before the N.R.C. on the matter of the financing of the Pilgrim II power plant last spring. . . . **Larry Rosenthal** is an engineer at a computergame company he founded called Vectorbeam. — **Dick Fletcher**, Secretary, 135 West St., Braintree, MA 02184

74

On a balmy Sunday in mid-October, we had an 80-degree day (26 Celcius), and I put a coat of paint on the steps. I wanted to remember that in January. The word from this column is MEAGER, but then, you're not to blame. It's the old time delay. It is 4-5 months from pen to print. And some news is even worse. You hadn't heard our pleas for news in October? Now you have no excuse. Write us. Now on with our meager column.

Richard Bennett is doing cancer research work in Hershey, Penn., at the Hershey Medical Center. The reason we know this is by a newspaper clipping that appeared in his hometown paper, announcing his receiving his Ph.D., in June. This is an elderly piece of news. Richard's phone number, by the way, can be had from Hershey directory assistance.

John Viggers, and his wife Terry are settled in their condominium in Reston, Va., by now. John left Hermosa Beach, Calif. (!) to come back East but promises he'll return again. John is doing something with computers on a Multics system. He and Terry are very happy. . . . **Bob Currier** is back from the Peace Corps in Malasia. . . . I saw an exhibition of photographs by **Roger Neal Goldstein** at The Darkroom in Cambridge. Now, I don't know much about art but I know what I like, and I was stunned by one of his photographs showing a derelict dead asleep on a white park bench. Some of his photographs will be on display again at The Darkroom the month of December.

Tim Hult was made the vice president of data processing at Epsilon Data Management Corp. in Burlington, Mass. Tim is living proof of the line in the Greatful Dead song *Truckin'*, "Sometimes the cards ain't worth a dime, If you don't lay them down." He left E.D.M. three times and returned, each time a notch higher. He and Mary want to start a family.

The M.I.T. Marching Band gave a "Salute to Brownian Motion" at the homecoming game by dutifully marching in all directions at once. And that was not the highlight of the day. The mostly-student crowd was raucous and spirited and we filled the grandstand. And to top it all off the Engineers walked all over the New York Maritime Academy 37-8. Not only a football team, but a football team that wins! The cheerleaders (seven women, three men) made effective use of "Beaver" references a number of times. You may use your imagination here.

I had a nice chat with **David Akin** about the research he's doing towards his doctorate at 'Tech. His thesis is on the optimistic prospects of using satellites to collect and beam down solar power. Some of the efficiencies involved make the idea very promising with the big issue being finding the bucks to put a five-by-ten-mile panel of solar cells into orbit. He has also been "Space Suit Qualified" at the N.A.S.A. neutral bouyancy facility for his work in measuring the productivity of people in space. Apparently, even though we were originally made to swing in the trees, we can do 20 times better in weightless conditions, principally because "things don't fall down." David is saying he'll be graduating in June, and good luck to him.

I promise that if we don't start hearing things from or about you soon, I will start making things up to fill the column. Don't wait until you're famous and we can all read it in the paper. Write now. — **Lionel Goulet**, Secretary, 34 Tremlett St., Dorchester, MA 02124; **Jim Gokhale**, 6 Burton St., Arlington, MA 02174

75

Here's my favorite class note for this time around. It came on a Fund envelope from **Jon Sass**, who wrote, "I collect business cards, anyone's. Send me all you have. Thanks." Of course Jon did not include an address for receiving the cards. Hence I'm not sure whether this is a real request or whether Jon is living up to his last name. In any event, Jon, if you read this and you really want our business cards (and I'm sure some of you folks out there would be happy to oblige) I looked up your current mailing address. Just say the word and I'll include it in my next column.

I know I reported this already but just to be safe I'll do it again. Besides, I loved the headline on the clipping from the *Lakeville (Conn.) Journal* that I received. It was dated July 5, 1979, which goes to show you what an up-to-the-minute column I write. Instead of current events I bring you class history. Anyway, the headline reads, "Miss Bergh Marries Kansan in Vermont," and that Kansan was none other than **Curt Terwilliger**. He and Caroline wed this past summer.

I have a couple of even older but nonetheless noteworthy items. From the *New Britain (Conn.) Herald* I see that **Joseph Sacco** received his doctor of medicine degree from the University of Connecticut School of Medicine. The clip was dated July 16, 1979, so I assume he graduated in June. Joseph will be interning at St. Mary's Hospital in Waterbury, Conn. Also interning in Waterbury, but I believe at a different hospital, is **Alma Murphy**. I bumped into her recently on Mass. Ave. She told me she's doing her internship in ophthalmology. And from the June 18, 1979 issue of the *Springfield Daily News*, I learned that **Allen E. Bale** received the M.D. degree from the University of Massachusetts Medical School in Worcester.

Mark Beasman has accepted a position with the consulting firm of Strategic Planning Associates in Washington, D.C. He says, "After some eight years in the Boston area, will miss the place." . . . **Marty Cawthon** is now in Dearborn, Mich. working as a manufacturer's representative for heavy meachnical equipment. He bought a sailboat and enjoys sailing on Lake Erie. He has also adopted (though he wrote "adapted," perhaps he has) a pet raccoon, "now one year old and quite an interesting beast." . . . **Richard C. Michel** is chief of engineering services at Naval Regional Medical Center, Yokosuka, Japan. . . . From the *Jewish Advocate* of Boston, I see that **Howard Finkelstein** has been named assistant for corporate development, B.B.I. Communications, Inc., the newly incorporated subsidiary of Boston Broadcasters, Inc. Formerly he was market development manager and finanacial analyst for C.B.S. . . . **Mary Ann Schmidt Hinden** wrote to say that she married Robert Hinden in August, 1977. She's working at Computervision Corp. in Bedford, Mass. as a group leader in the software development department. She and her husband were expecting their first child in October. . . . Ran into **Eric Rosenfeld** in the Harvard Coop recently. I don't know which one of us was more desperate to get our rebate checks — probably I, since he's finishing up his doctorate at Sloan and has already started working at the Harvard Business School, where I understand **Dennis Crumpler** is in his first year.

I attended the Alumni Officers' Conference in September and enjoyed a hilarious dinner at the Hyatt with Jimmy Gokhale, '74, a fellow class secretary. Also there were **Jim Moody** and **Anita Horton**. Didn't get a chance to speak with Jim, but Anita, who also attended the first official meeting of our 5th year reunion committee, is still living and working in Luxembourg.

Now that I've introduced the subject; let me reunion is coming up in June and **Rich McCarthy**, **Ales Castaldo**, **Charles Fendrock**, **Dave Wargo**, and I are busily making plans for it. Hope you all will try to make it. Happy holidays! — **Jennifer Gordon**, Secretary, 22 Centre St. No. 9, Cambridge, MA 02139

76

I must sorrowfully report the death of **Jeffrey H. Kazdan** which took place on July 28, 1979. Jeffrey lived in Burton House and majored in economics. He is survived by his parents and brother Bruce. He will be missed.

From the mails, we learn that **Jay Gurley** is working for Motorola in their communications products division in Fort Worth, Tex. Jay finished his M.S.E.E. last August at the 'Tute and now finds Texas "humid down here, so 95°F is warm but not intolerable." . . . **Zachary Levine** has been awarded a Dean's Fellowship at Penn. He was one of 34 chosen from the university — apparently the Philadelphia climate is agreeing with him. . . . **George Diomitriou** has been promoted to the position of financial analyst officer at the Third National Bank of Springfield, Mass. He joined the bank in July, 1978 as a financial analyst in the portfolio dept. Our congratulations — we now have a bank officer in our class, and in these times that may be something some of us will want to bear in mind.

Olimpio Demarco wed Jennifer Lenter, whose father is also an alumnus, on August 19. My thanks to Richard Field, '78, best man, who sent me the news. . . . I caught **Raphael Blumpkin** as he was passing through Boston. Raphael is at the University of Chicago Business School, where he has had to adapt to the quarter rather than the semester system. Just as Raphael starts to warm up to a course, it ends. . . . "The intimidating thing about the quarter system is having mid-terms during the fifth week of the term — at M.I.T. I didn't even open my textbooks until the fifth week of the term!" He tells me the school is excellent, except for the obeisance to Milton Freedman in all his economics courses. In addition to doing schoolwork, Raphael has written six chapters of a novel based on a multi-generation immigrant family.

While in Detroit for a weekend, I had the pleasure of bumping into **Sue Litvin** at Meadowbrook, Detroit's equivalent (and in my chauvinistic view, inferior!) to Tanglewood. Sue is in charge of the alumni activities for the M.I.T. Club of Detroit and is still working happily at Ford. . . . And from the commodity markets, we have interest rates and foreign exchange, foreign exchange and interest rates. They make such a merry dance together. — **Arthur J. Carp**, Secretary, Endymion Commodities, Inc., 131 State St., Suite 616, Boston, MA 02109

77

To kick off this month's column I managed to dig around in the files and find a longlost letter from **Glen Brownstein**. Never one to sit still, he's moved

around quite a bit in the past two years. First, he traipsed off to Northwestern University's Medill School of Journalism where he completed his master's degree in 15 months, including one quarter working in Washington, D.C. as a government reporter and stringer for the *Green Bay Press Gazette* and the *Bend* (Oregon) *Bulletin*. He also spent three months in the fall of '77 as an intern with the Bend paper near Mt. Bachelor just the other side of the Cascades. "Wow, what beautiful scenery," he says. "Good paper, too." When the letter was written he was a sports writer for the *Metro East Journal*, a daily/Sunday paper in East St. Louis, Ill., with a circulation of 40,000. He gets to cover prep and college sports and lots of features, including the Cardinals. He has also managed to get himself married to a young lady named Deborah Hartman from Leslie College, class of 1978. He met her as a blind date at a Fiji Island party in 1975. He goes on to say, "I read about all these process engineers and industrial consultants we've got after a year and a half, all these neuroscientists and honor medical students, and I wonder what I'm dong working as a sports writer. Then I realize that when they are through working, a lot of them probably pick up the local paper to read the news and sports and be entertained and informed. So what the hell, it's a living, and it pays great and it's lots of fun. I promise not to wear my lemon-yellow "Wide World of Sports" blazer at the class reunion." Sounds like he's doing exactly what he wants to do.

Julia Malaki finished up her master's degree in business adminstration from the University of Chicago with concentrations in accounting and finance. She is now working as a corporate financial analyst for General Motors in Detroit. . . . After completing a master's degree in a year at Stanford, **Cliff Edson** is working for National Airlines in sunny Florida. He is in the strategic planning group and was involved in all the merger and acquisition activity that National underwent in the past few months.

James A. Torma received his master's degree in mechanical engineering from Case Western Reserve last May, and is now working for Celanese Chemical Co. in Corpus Christi Tex. . . . **Christine Dowler**, late of Burton Four, is playing a lot of bridge in Newark, N.J., these days when she's not working for Continental Oil Co. . . . Out on the West Coast, **Kenneth Sun** finished up at the University of Washington with a master's degree in aeronautics and astronautics and is now working for Lockheed Missiles and Space Co., in Palo Alto — not a bad place to be at all, I imagine.

Speaking of missiles, **Brian Hughes** finished up at that other business school up the river and is helping to insure satellites. Yes, that's right, folks. He is a satellite system analyst for Corroon and Black, Inc., in Washington, D.C. They write insurance for communication satellites against such contingencies as launch failures, system malfunctions, and material failures. He's pleased with the whole thing and "feels guilty about being paid for going to work at a job every morning that allows him to do exactly what he wants to do." From Count UMOC to Buck Rogers — not a bad step at all. . . . **Scott Burkhardt** is employed by Proctor and Gamble in Cincinnati as a project manager, working on projects such as video inspection, quality and process control, and microprocessor-based interfaces. He has also been active in the Cincinnati Ski Club as winter member group. . . . **Sergio Cabrera** received his master's degree in electrical engineering from the University of Arizona this past May. . . . **Chris Donnelley** is happily tooling away as a law student at the University of Michigan Law School. He has been writing on child pornography — I wonder if he can get me Larry Flint's autograph?

Jim Eisen also went on to law school — at N.Y.U. This past summer he worked on Wall Street for a firm specializing in international law. . . . Earlier this year **Richard Buck** wrote, "I am currently working for a small consulting firm in Arlington, Va. My activities run the gamut from programmer to telecommunication systems analyst on a number of government contracts. I'm keeping up my soccer — I just passed the referee exam and am playing on a team in the Northern Virginia Coaches League."

Matthew Sherman seems to be doing quite well in the M.D./Ph.D. program in biochemistry at Dartmouth Medical School. He has done some psycho-pharmacology research at McLean Hospital in Belmont. Among his classmates are **Nina Caham** and **David Fett**.

Among the thousands at the Fourth of July concert on the Esplanade, who should I run into but **Gary Pajer**? He was to be married in August to Leslie Richardson (Wellesley '77), and they were planning a honeymoon in Bermuda. He's "killing babies for Northrop," and Leslie had just finished a graduate degree at Boston University, where she had been teaching autistic children.

Finally, I received this letter from **Eileen Schaffer**: "I'm still working at Lawrence Livermore Labs in the seismology group. Since I left M.I.T. I've become an avid runner; I've run three marathons in the last year and run an average of 40 to 50 miles per week. I've yet to qualify for Boston, but I haven't given up yet. I also have some news on another classmate — **John Ottusch**. John is a graduate student at Berkeley, working in astrophysics with Professor Charles H. Townes. He has made two trips to Kitt Peak Observatory in Arizona and has become a real bicycle enthusiast. He's completed a few 200-kilometer bikes rides, and in May he rode the 200-mile Davis Double Century. We both just love California — the Bay Area especially. John is living in Berkeley and I am still living in Walnut Creek."

As for myself, I finished up at the Sloan School and have happily settled down in Green Bay, Wis. I'm doing corporate planning and business analysis for a cheese manufacturer and distributor. It's really not a bad area of the country, but then I haven't seen a winter yet. Anybody visiting please feel free to drop in. — **Doug McLeod**, Secretary, 1641 Smith St., Green Bay, WI 54302

78

In the last dying days of summer I was wandering around Cambridge near M.I.T. and ran into a classmate who had written to me early last year. Apparently I had published too much of her letter! Not that what I had published was confidential, but she just didn't want it in this column. As a result I send this warning to those of you who are frequent correspondents: I will only publish what you specifically tell me is permissible.

So, let's see who we can slander this month. My old friend **Regina (Queenie) Wiedenski** writes from New York, saying that all things in the Big Apple are "just peachy." She says that she runs into **Dianna Burton** often in "the city." Dianna is working for International Paper. Regina stayed an extra year at Sloan in order to get her master's and is now working for Morgan Stanley, an investment bank. Her big news, though, is her recent engagement to Brian Backner, '77, currently a medical student.

Dan Morrison and **Beryl Nelson** were married in Boston on September 8. They are now living in Salt Lake City and are teaching at the University of Utah, where they are both candidates for Ph.D.'s . . . **Dorothy Keverion** (formerly Dorothy Klepacz) is braving the wilds of another college town — Madison, Wis., — where she is working for Exxon. . . . **Timothy Gawne** writes that he has just started a four-year Ph.D. program at the Uniformed Services University of the Health Sciences at Bethesda, Md., under the National Institute of Health. Tim spent last year as a research engineer at Digital Equipment Corp. in Marlboro, Mass.

Julie Keller is now at the University of Minnesota Medical School and is living in Minneapolis. . . . **Moshe Sadofsky** writes from the University of Pennsylvania Medical School to say, "Hi." He's concurrently working on a Ph.D. in genetics.

They say that Caltech is our West Coast counterpart, but **Dan Zwillinger** wasn't so thrilled. He writes: "After one year of Caltech, I find it to be much more research oriented than M.I.T. There are fewer engineers and miserable computer facilities." It sounds like he's really roughing it out there — technologically speaking.

We have a new class agent — **Larry Yablong**, a tireless worker during preparations for senior week activities. Larry will be in charge of raising funds from the class for the yearly M.I.T. Alumni Fund, but knowing Larry he'll volunteer to do lots more. Hey, Larry, how would you like to write one of these columns? But seriously, I'm sure Larry will do a superb job and I'd like to wish him my personal congratulations and some good luck.

Well, the time is running thin and so is the news. I'm smack in the middle of a tough semester at the University of Michigan Law School but enjoying the battle. A word of encouragement to any future second-year law students: the second year is infinitely better than the first. I want to encourage you folks to keep writing; it's kind of like sending letters to *The Tech*: if you don't write me how can I misquote you For now, this is your news-starved secretary wishing you a warm winter and happy holidays. — **David S. Browne**, Secretary, 1026 Vaughn St., Number 6, Ann Arbor, MI 48104, (313) 995-9806

79

Hello, fellow class members!! Many of you have been too busy making your first million to write, but there are a few noteworthy tidbits.

Bonnie Mason writes from Mountain View, Calif., where she is a research and development engineer for HewlettPackard. "It's interesting, boring, frustrating and challenging — depending upon what day you ask me." Although she finds the West Coast prices much higher than those in New England, she reports, "California is great, and the weather — well, it beats Boston hands down!" After spending four years in the M.I.T. housing system, Bonnie's new apartment is suffering from something which I'm sure many of you are also experiencing — dearth of furniture!! If any class members in her area are looking to sell some, do write and let us know.

Jukata Nakajima wrote from his native Japan, where he returned in March after finishing up his physics degree. He's working in Tokyo for Hitachi Corp., a large manufacturer of electrical machinery which he claims is the Japanese counterpart of General Electric. Yutaka says of his job in the field of semiconductors: "I'm enjoying my work more and more, but it's getting tougher and tougher." He appeals to his friends here in the U.S. to keep in touch with him through the Class Notes (I'm all for that!).

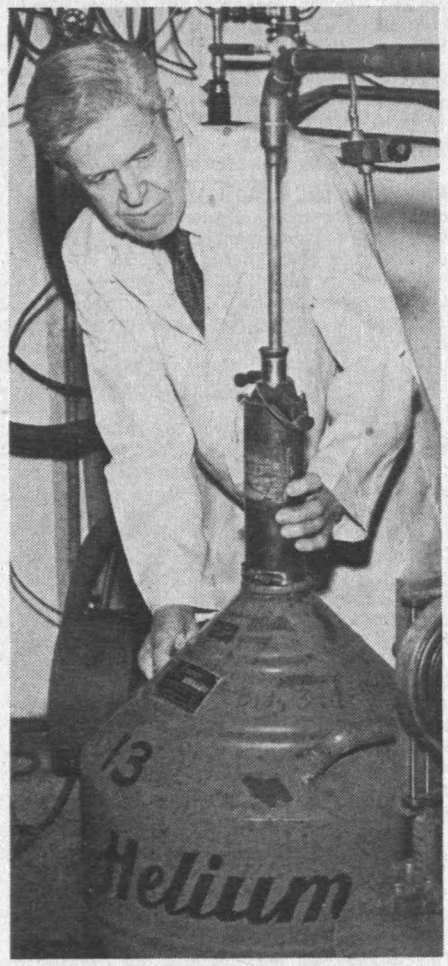
When **Ken Keverian** and Dorota Klepacz, '78, were married in August, several class members were there to enjoy the fun: Best Man **Fred Beretta**, Ushers **Lee Boy** and **Ron Parton**, and **Bob Light** and **John Wozniak** (not to mention yours truly!). Fred and Bob are both working for their masters degrees in mechanical engineering back at the 'Tute. Ron is back home in Iowa City attending the University of Iowa Medical School. Lee and his new wife **Valynn Knight** are both employees of Procter and Gamble in Cincinnati. Best of luck to you, Dorota and Ken!

Congratulations to **Preston Vorlicek**, who has been awarded an N.C.A.A. postgraduate scholarship. The scholarship is only given to fifteen Division III athletes nationwide each year. An aeronautics and astronautics major, Preston will assist in coaching the varsity swim teams while doing his graduate work at M.I.T. . . . **Beth Marcus**, the proud recipient of a scholarship to study in England, is living in London. . . . **Bob Staff** and **Keith Goldstein** were sighted by one of my spies at the Medical School at S.U.N.Y Buffalo. . . . Here at the University of Pennsylvania, I was pleased to run into **Beth Broome**, who's a first-year student at the medical school, and **Steven Feldman**, who's with me at the Wharton School of Business.

Happy Holidays to all!! Don't forget to put "Write Sharon" on your list of New Year's Resolutions! — **Sharon Lowenheim**, Secretary, 3600 Chestnut St., Box 1166, Philadelphia, PA 19104

Courses

A. Gaudy



"Work is my hobby," says Samuel C. Collins, professor emeritus of mechanical engineering at M.I.T. who's now engaged in cryogenic engineering at the Naval Research Laboratory in Washington. The equipment in the picture is a prototype helium liquefier developed for the Navy's proposed surperconducting ship propulsion systems; two models developed by Professor Collins — their capacities range from five to 20 liters of liquid helium an hour — are now being tested by the Naval Ship Research and Development Center. Professor Collins retired from M.I.T. in 1964 and retired from his next job as vice president of Cryogenic Technologoy, Inc., in 1971 to go to N.R.L.

Cryogenic Power for the Navy from Samuel C. Collins at 80

"I don't smoke, imbibe very little, take lots of exercise, and work hard. It keeps my mind busy and my body young."

That formula from Samuel C. Collins, professor emeritus of mechanical engineering who's now on the staff of the Naval Research Laboratory, Washington. At age 80, he's credited with developing a new helium liquefier to supply superconducting motors and generators aboard future naval vessels.

The new machine is 20 per cent more efficient than liquefiers previously available, is smaller, and can withstand heavy shocks. The Navy says it brings closer the goal of cryogenic machines for the new, fast surface-effects ships which are a major program of the Naval Ship Research and Development Center.

Firmenich Professorship

Firmenich and Co. of Princeton, N.J., has endowed a career development professorship in the field of natural products chemistry, and William H. Rastetter, '71, assistant professor of chemistry whose special interest is the synthesis of biologically active compounds, is the first holder of the chair.

The Firmenich firm in the U.S. is associated with Firmenich SA of Geneva, Switzerland, a major international manufacturer of fragrance, flavor, and aroma chemicals for the perfume, food, and beverage industries. By "natural products," the firm meant to cover such naturally occurring chemical substances as proteins, enzymes, vitamins, hormones, and others.

Dr. Rastetter, whose advanced degrees are from Harvard (M.A. 1972, Ph.D. 1975), is called "one of the most promising young synthetic organic chemists in the country" by James L. Kinsey, head of the Department of Chemistry.

I

Civil Engineering

Passive solar homes premanufactured by **James Kachadorian,** S.M.'62, as founder and owner of Green Mountain Homes, Royalton, Vt., have gained recent notoriety. There has been national recognition from such organizations as the National Passive Solar Institute, the American section of the International Solar Energy Society, Inc., the National Woodwork Manufactures Association, *Solar Engineering* magazine, and *House and Garden* magazine; and Sandia Laboratories has now rated Mr. Kachadorian's among the top 15 passive solar heated buildings of 1979.

John A. Downs, S.M.'38, is now chairman and chief executive officer of Great Lakes International, Inc., and its principal subsidiary, Great Lakes Dredge and Dock Co.; he had been executive vice president of the latter. . . . **Richard Sullivan,** S.M.'62, is town engineer of Wallingford, Conn., having left a similar post in Guilford, Conn. . . . **Anthony Gaudy,** S.M.'55, is Rodney H. Sharp Professor and chairman of the Department of Civil Engineering of the University of Delaware; he was previously on the faculty of Oklahoma State University.

Roger F. Gardner, S.M.'76. died on August 2, the victim of a heart attack while jogging near his home in Andover, Mass. He was employed by Geotechnical Engineers, Inc., of Cambridge and had been notably active in work with young people at West Parish Church, Andover. He is survived by his wife, the former Debbie K. Hancock, who was expecting the couple's first child at the time of Roger's death, and by his parents and a sister.

II

Mechanical Engineering

Richard D. Nathenson, S.M.'72, writes that he is a member of the team designing the first 300 MVA. superconducting generator at Westinghouse Electric Corp.'s Research and Development Center; the $20 million contract is with the Electric Power Research Institute. . . . **Charles R. Faulders,** Sc.D.'50, is marketing representative for coal liquifaction and gasification systems under development by the Energy System Group of Rockwell International.

George S. Reichenbach, Sc.D.'52, is now vice president and general manager of the Materials Division, Norton Co.; he had been divisional vice president and general manager for organic products in the Grinding Wheel Division.

An Energy-Conscious House for Boston

When Barbara Putnam, M.Arch. '77, and her colleagues at Total Environmental Action, Inc., architects and engineers of Harrisville, N.H., started work for the A.I.A. Research Corp. on a "minimum energy dwelling" for the Boston area, their goal was to draw plans for a "zero energy house" — meaning a house that could heat itself.

It didn't work out quite that way.

But the three-story (five-level) design for which Ms. Putnam was project manager incorporates a wide range of energy-saving features, and its energy requirements are minimal. There are three bedrooms and two baths — a total of 1,700 square feet of usable space; and at the top of the house is a "belvedere" with windows which admit generous light and — in the summer — provide ventilation.

The house would use 15.5 million B.t.u.s of energy for hot water every year, 17.7 million B.t.u.s for lighting, and 32.6 million B.t.u.s for space heating. "Passive" solar heating would add 18 million B.t.u.s, covering in all about 36 per cent of the house load.

At prices prevailing in mid-summer 1978, the house would cost just over $76,000 to build in the Boston area. Of that total, only about $7,000 represents the cost of adding its special energy-conservation features.

Among those special features:

☐ Heavy insulation throughout.

☐ An L-shaped floor plan, oriented so that the house presents two "inside corners" toward the southwestern winter sun and summer breezes.

☐ An attached garage on the north, to provide protection against winter winds.

☐ Large south-facing windows backed by vertical tubes containing water. Heated in sunlight, the water will retain and gradually dissipate its heat during sunless hours. At least one such "heat-harvesting" window is included in every room in the house.

☐ Small windows on east and west.

☐ A belvedere with large windows at the top of the house to provide light year-around and bountiful warm-weather air circulation to eliminate the need for air conditioning.

☐ Sliding shutters to be drawn across windows on cold winter nights and shades above them to deflect the hot summer sun.

☐ Double doors on all exterior entrances to create air locks and reduce infiltration of outside air.

☐ Centrally located kitchen so that its excess heat will be available to the house.

☐ Fluorescent lighting throughout, much of it concealed to serve as indirect illumination.

☐ Transoms above bedroom doors for summer ventilation and grills in the upstairs floors for winter gravity heating — possibly from a single floor furnace under the main floor.

☐ A full basement large enough to air-dry laundry, thus eliminating need for an automatic dryer.

III
Materials Science and Engineering

From **Douglas E. Holmes,** Ph.D.'77: working on compound semiconductor materials at Hughes Research Laboratory, Malibu, Calif. . . . **David Lewis Holt,** Ph.D.'65, having turned to the ministry in 1969, completed his bachelor of divinity degree at the Episcopal Divinity School, Cambridge, in 1978. He was ordained to the Sacred Order of Priest on June 2 at the Grace Church (Federated) in East Boston, where he is pastor.

Mireille T. Clapp, Ph.D.'78, is assistant professor of materials in the Department of Mechanical Engineering at the University of Massachusetts, Amherst. . . . **William A. Griffith,** S.M.'50, is president and chief executive officer of Hecla Mining Co., Wallace, Idaho. . . . **Charles W. Finn,** Ph.D.'71, senior lecturer in pyrometallurgy in the Department of Metallurgy of the University of the Witwatersrand, Johannesburg, has been appointed honorary leader of the Pyrometallurgy Research Group of the South African National Institute of Metallurgy.

IV
Architecture

Robert S. Allan, M. Arch.'55, has expanded his office in architecture, engineering, and planning by opening a management consulting service and increasing his office space; alumni are invited to visit when they are in Dallas. . . . After being with Leonard Parker Associates for eleven years, **Ray W. Geiger,** M.Arch.'65, has opened his own office in the practice of architecture; he is also in his eighth year as visiting lecturer and design critic at the Department of Architecture, University of Minnesota.

"Crystal Passage," a work by **Jeffrey Owen Brosk,** M. Arch.'76, was exhibited from August through October in the Hammarskjold Plaza Sculpture Garden, Second Avenue at 47th St., New York City. . . . The Roger Williams Park Zoo in Providence, the work of **William L. Kite, Jr.,** M. Arch.'61, and Geoffrey H. Palmer of the Architects Design Group, Providence, was chosen for an Excellence in Architecture Award by the New England Regional Council of the American Institute of Architects. . . . **Glenn R. Merithew,** '59, who joined Anderson-Nichols and Co., Inc., Boston, as director of architectural design in 1978, has been named to the additional post of vice president of the firm. Charles Dudinski, president of the firm, says Mr. Merithew "has been noticeably successful in upgrading the visual quality of buildings being designed by Anderson-Nichols.

V
Chemistry

Having received the Secretary of Defense's Meritorious Civilian Service Medal for his contributions as program manager with the Defense Advanced Research Projects Agency, **Philip A. Selwyn,** Ph.D.'70, has become chief scientist in the Security Technology Program, Strategic Systems Projects Office, U.S. Navy. . . . Professor **Donald R. Wiles,** Ph.D.'53, is now chairman of the Chemistry Department at Carleton University, Ottawa, Canada. . . . **David B. Ledlie,** Ph.D.'66, has been promoted from assistant to associate professor of chemistry at Bates College. . . . **Richard W. Eddy,** S.M.'48 vice chairman of Union Carbide Europe, Inc., has been elected to a two-year term on the Board of Trustees of the Ohio University Fund, Inc.; Dr. Eddy studied at Ohio University before coming to M.I.T., and he received that university's honorary doctor of science degree in 1978.

As chief of the National Bureau of Standards' Organic Analytical Research Division, **Harry Hertz,** Ph.D.'71, directs the development of clini-

cal and environmental reference standards; he was installed this fall as a member of the Board of Directors for the National Committee for Clinical Laboratory Standards. . . . **Ernest R. Gilmont,** Ph.D.'56, general manager of Copygraphics, a leading manufacturer of toners and developers for copying machines, received a presidential citation of merit from the American Institute of Chemists last May in Philadelphia; he was cited for his "exceptional innovation and creativity in addressing the problems which face the individual chemist and chemical engineer in his professional environment."

VI

Electrical Engineering and Computer Science

Lieutenant Colonel **William H. Crabtree,** Sc.D.'62, chief of the Systems Engineering Office for the MX ICBM Program, holds the 1979 Engineer of the Year Award of the Arrowhead (Calif.) Section of the American Institute of Aeronautics and Astronautics. . . . **Earle W.DuBois,** S.M.'50, formerly general manager of uranium resources at Westinghouse Electric Corp., is now vice president — corporate relations of the company. . . . When Sperry Rand Corp. established a staff in its office of the chairman, **Gerald G. Probst,** S.M.'56, group executive vice president, was among those picked.

Walter Gajda, Jr., Ph.D.'70, associate professor of electrical engineering at Notre Dame University, holds the College of Engineering's 1979 Outstanding Teacher Award; Professor Gajda, who had primary responsibility for developing the introductory freshman engineering course at Notre Dame, is called "a model of what a teacher can be." His research is in the electrical properties of lightweight composite materials.

Two alumni of the department are now on overseas assignments as the recipients of Fulbright Awards for 1979-80: **Edward J. Craig,** Sc.D.'54, professor and chairman of electrical engineering and computer science at Union College, is lecturing in electrical engineering at University of Liberia, Monrovia; and **Omar Wing,** S.M.'52, professor and chairman of electrical engineering and computer science at Columbia University, is spending four months in research on parallel computational algorithms at the Technical University at Eindhoven, Netherlands.

Jeffrey A. Kaplan, S.M.'71, has been promoted to manager of major programming projects at Leeds and Northrup Co., North Wales, Pa.

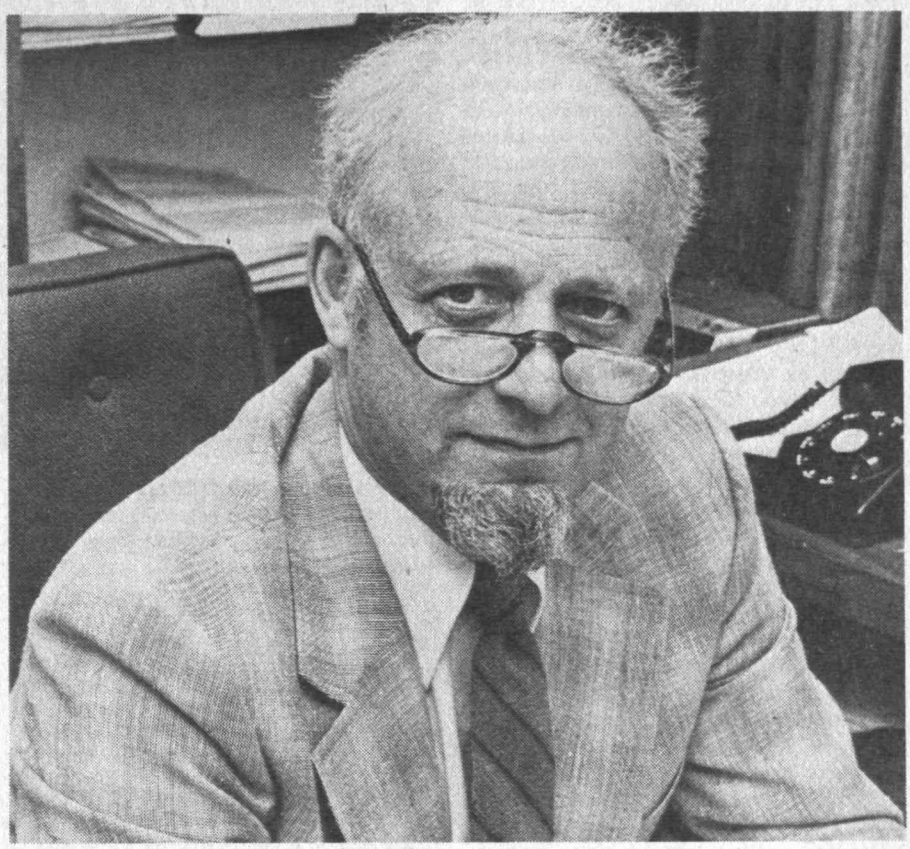
VI-A

Cooperative Course in Electrical Engineering and Computer Science

In the summer of 1979 Course VI-A had the largest number of students on work assignments in its history. John A. Tucker, director, visited enthusiastic students at Motorola in Chicago; Fairchild, Hewlett-Packard, I.B.M., and Xerox in the San Francisco Bay area; and Texas Instruments, Inc., in Dallas during August. During his visit, students on the West Coast arranged a picnic in Fair Oaks Park, Mountain View, Calif., for all the VI-A'ers in the area. Alumni/ae who joined us included seven now working with Hewlett-Packard in Palo Alto: **Wayne D. Baron,** '76, **Allen J. Baum,** '74, **John F. Cooper,** '74, **Richard C. Palm, Jr.,** '74, **Lynn M. Roylance,** '72, **Eric A. Slutz,** '74, and **Kenneth A. Van Bree,** '71; and two now working with Hewlett-Packard in Cupertino: **Brock C. Krizan,** '75, and **John D. Williams,** '76.

During Mr. Tucker's Dallas visit **Cecil H. Green,** '23, again hosted his annual VI-A luncheon for students, managers, and executive personnel at Texas Instruments, Inc. Among those present: **Joseph D. Zimmerman,** '59, group vice president at T.I., and **Dean R. Collins,** '58, a manager in T.I.'s Central Research Laboratory who is the technical coordinator for the VI-A program at T.I.

Before taking up his duties as President of the University of Toronto, James M. Ham, Sc.D. '52, had risen through that University's Department of Electrical Engineering to become its chairman, then dean of the Faculty of Applied Sciences and Engineering (1966 to 1973), and finally dean of the School of Graduate Studies. Thirty-two years ago he brought his University of Toronto bachelor's degree to M.I.T. for graduate study in automatic control, and he continued on the M.I.T. faculty until 1952, when he returned to teach in Toronto.



Toward the Wholeness of the University: "Have an Argument in a Pub and Let Me Join"

This is the dilemma of the modern university, says James M. Ham, ScD. '52, who is completing his first year as president of the University of Toronto, Canada's largest:

Given the increasing fragmentation of knowledge and the competition for energies and funds among research, scholarship, and teaching, how can it find and embrace the unity which is inherent in the knowledge it teaches?

Think of a university as "an academic city," President Ham asked his audience at his installation late last year. It has four concentric circles, with the roots from each extending inward toward the center.

In the outer ring are the professions — engineering, medicine, law, and management; from the inner rings they must draw both "the scientific and the humane knowledge that characterize their capacity for service to the public good."

Next come the social sciences — anthropology, geography, economics, political science, urban studies.

Then come the physical and life sciences — the "branches of our understanding that have sprung out of the creativity of the reasoning mind."

And finally, in the central ring from which are nurtured all the others, are the humanities. Their role is to "define the shape of civilization and help the individual find himself in his uniqueness.

"The informing principle is that mere knowledge must be refined into truth and wisdom in the crucible of a coherent educational experience distinguished by form and continuity," said Dr. Ham. "Let us see in our mind's eye a *uni*versity rather than a *multi*versity."

As he proceeds with his work as president, Dr. Ham apparently finds this issue remaining high on his agenda. "Are we so divided in our individualism and the diversity of our pursuits," he asked in a guest editorial in the university's community newspaper early this year, "that we lose the sense of sharing a lively tradition?"

Dr. Ham admitted that any university is surrounded by "the mechanisms of credits, sections, computer-managed reports, and fast-food services. But must these become dominant over the corporate life implied by classes, colleges, and pubs where one can break bread, quaff beer, and engage in good argument about the human condition?" he asked.

His wish for his readers: "Have an argument in a campus pub, and on occasion grant me the privilege of joining you."

Strands for Strengthening the Industry-University Connection

A modern paradox, says Edward E. David, Jr., Sc.D. '50, president of Exxon Research and Engineering Co.: most basic science is done by universities, but most applications in the form of technological innovation take place in industry.

The system has worked, said Dr. David in his address as president of the American Association for the Advancement of Science last January in Houston, Tex., because there are a host of informal connections between university science and industry technology: visiting professorships, student internships, publications and professional meetings, panels and committees . . .

But conditions in both industry and university are changing, Dr. David told the A.A.A.S., and today's informal mechanisms may not be adequate for the future. "The time has come for a closer and more intimate relation between industry and academia," said Dr. David.

Dr. David admitted that it's unfair to categorize too sharply indutry's and the university's contributions to modern technology. Much of what goes on in industrial laboratories has the character of basic research, he said, and a good deal of innovation takes place in the universities. Dr. David agrees that traditional relationships have been "long and fruitful," but he hopes for new mechanisms for interaction; especially he wants relationships which go beyond philanthropy (though he admits that "contributions of relatively modest unrestricted funds to the universities can produce benefits far out of proportion to their amounts") to result in "working connections." Examples:

☐ Joint research has often foundered in the past because of the apparently conflicting roles of industry and university. But he sees progress, and foresees more.

☐ Advisory committees to bring academics into industrial laboratories and vice versa are widely used.

☐ A new kind of industry-university contract — a pioneering example was cited between Harvard and Monsanto, which provides support for certain faculty members and their activities and for the involvement of Monsanto in those activities for a realtively long period — looks to Dr. David especially promising.

☐ Cooperation which focusses on public policy issues is especially important because studies of policy issues by industry are in general "not credible," said Dr. David. In this case, the university can take the role of "honest broker."

"I do not expect to see an immediately warmer embrace" between industry and university, said Dr. David. "But ten years from now I do expect to see a vigorous community of industrial-academic scientists with its academic members enriching industrial research and industrial organizations providing the link of commercialization."

At the Petroleum Club in Dallas last August, Cecil H. Green, '23 (center), entertains Course VI-A students working for the summer at Texas Instruments, Inc., of which Mr. Green is honorary chairman. With him are John H. Tucker (left), director of the VI-A Program, and George L. Berryman, T.I.'s director of corporate college relations.

Other notes of interest about VI-A people: **Paul E. Stoft,** '49, a director of Hewlett-Packard's Corporate Laboratories, was at M.I.T. in October for the symposium on "Technology, Innovation, and Industrial Development." . . . **Herbert D. Benington,** '50, vice president of Mitre Corp., is general chairman of EASCON '79. . . . **Daniel G. Jablonski,** '76, was in the country for a month on vacation from his studies for a Ph.D. at Cambridge University. . . . **Paul D. Palmer, Jr.,** '71, said hello to Director Tucker while the latter was visiting the White Oak Laboratory of N.S.W.C. in July . . . **Kelly M. Pan,** '78, is now working in the Corporate Research Group at Digital Equipment Corp. . . . **John J. Paulos,** '79, and his wife, the former **Susan J. Kaufmann,** '79, were appointed graduate residents at M.I.T.'s New West Campus Houses. **Lynn M. Roylance,** '72, was married on June 21, 1979, to **J. Payne Freret, Jr.,** '68. . . . **Charles B. Roxlo,** '79, has been appointed a graduate resident at East Campus, M.I.T. . . . **D. Max Snodderly, Jr.,** '62, called while at M.I.T. on business; he is with the Eye Research Institute of the Retina Foundation in Boston. . . . **Edward C. Whitman,** '61, has received a one-year appointment under the Navy Science Assistant Program as science adviser for the Commander of the Sixth Fleet in Naples, Italy; he will be on leave as head of the Mine Electrical Systems Division at the White Oak Laboratory, where he has been instrumental over the years in coordinating the placement of VI-A students.

Other recent visitors to the VI-A office: **Frederick R. Cronin,** '53, now with General Datacomm, Inc., Danbury, Conn. . . . **Amratlal C. Lodhia,** '77, supervisor of advanced courses and engineering at General Electric, Erie, Pa. . . . **Jeffry R. Long,** '74, on campus recruiting for Texas Instruments, Inc. . . . **Charles A. Kaminski,** '70, with North American Video Corp., Acton, Mass. . . . **Philip O. Martel,** '71, an engineer on advanced development projects with General Electric in Pittsfield. . . . **Steven E. Richardson,** '73, recruiting for Hewlett-Packard, Boise, Idaho. . . . **S. Dana Seccombe,** '70, recruiting for Hewlett-Packard, Fort Collins, Colo. . . . **Lewis R. Smith,** '57, an engineering manager with Burr-Brown, Tucson, Ariz. . . . **David D. Terwilliger,** '35 . . . and **Martin M. Weaver,** '31, recently retired as vice president of Acacia Life Insurance Co. — John A. Tucker, Director, Course VI-A, Room 38-473, M.I.T.

VII
Biology

Sandra Hilliker, Ph.D.'74, visiting assistant professor at Bucknell University, is working on genetic and biochemical studies of bacterial viruses under a $114,663 grant from the National Institutes of Health; it's the largest research grant ever received by a member of Bucknell's biology faculty. . . . **Theodore Jones,** Ph.D.'66, is chairman of the Chemistry Department at the University of San Francisco.

VIII
Physics

Michael K. Wilkinson, Ph.D.'50, director of the Solid State Division at Oak Ridge National Laboratory, is a member of the Executive Committee of the Condensed Matter Physics Division of the American Physical Society. . . . **J. Edward Neighbor,** Ph.D.'60, who became professor of physics at Northeastern University in 1978, is now associate dean of the College of Arts and Sciences. . . . Since last August **William R. Neal,** Ph.D.'64, has been a member of the Technical Staff of Mitre Corp., Bedford, Mass.

After two years as under secretary of the Air Force, **Hans M. Mark,** Ph.D.'54, became secretary on July 26; he had been serving as acting secretary since May. Dr. Mark joined the federal service in 1969 to be director of the Ames Research Center (N.A.S.A.); previously he had taught at M.I.T. and the University of California, Berkeley, and he continued as lecturer at the University of California, Davis, and Stanford while at Ames.

Solomon J. Buchsbaum, Ph.D.'57, is vice president — customer systems at Bell Telephone Laboratories; he had previously been vice president — network planning and customer services. . . . **Elias Burstein,** '43, was honored with the John Price Wetherill Medal of the Franklin Institute in October "for outstanding contributions to the science of optical properties of solids and its application in photoconductive technology." He is professor of physics at the University of Pennsylvania.

Though they hear fewer of them than M.I.T. students, Harvard Medical School students appreciate lectures by Dr. Walle J. H. Nauta, Professor of Neuroanatomy at M.I.T., just as much — or even more. So they gave Dr. Nauta their Boylston Award for Teaching Excellence last spring; the picture shows the winner with Joan Turner, Co-Chairman of the Boylston Society (Harvard Medical School students), who made the presentation.

IX
Psychology

Paul Abplanalp, Ph.D.'68, is director of the Basic Health Sciences Division at the New England College of Optometry, Boston.

X
Chemical Engineering

A complaint from **Robert Flanders,** S.M.'58: he retired from Stone and Webster in December, 1977, but "didn't like it"; so he's gone to work as senior applications engineer at NRC, Inc., Newton, Mass., the tantalum specialists. . . . Another retiree, **William S. Hutchinson, Jr.,** S.M.'49, is studying part-time as a candidate for a bachelor's degree in literature at the University of North Florida.

Samuel W. Bodman, III, Sc.D.'65, has become a director of Marathon Manufacturing Co., Houston; Dr. Bodman is president of Fidelity Management and Research Co. and chairman of Fidelity Venture Associates. . . . **Frederic A. L. Holloway,** Sc.D.'39, recently retired as vice president — science and technology at Exxon Corp., is now a director of Exxon.

J. Peter Jones, Ph.D.'74, is director of the master's degree program in environmental science and engineering at the University of Sherbrooke, Quebec. . . . "Trends in the Petrochemical Industry" was the subject of **Daniel S. Maisel,** Sc.D.'47, senior planning adviser for the Chemical Technology Department of Exxon Chemical Co. at the Monterrey Institute of Technology (Mexico) in October. "Inflationary economics, petroleum production limitations, and toxicological and environmental concerns" were listed by Dr. Maisel (speaking to the V Symposium of Chemical Engineering) as major factors affecting the industry in the next 20 years.

XI
Urban Studies and Planning

Understanding Neighborhood Change: The Role of Confidence in Urban Revitalization is the title of a new book by **Rolf Goetze,** Ph.D.'70. (Cambridge, Mass.: Ballinger, $14.50); in his foreword, Neal R. Peirce calls it "an opening wedge into looking at the dynamics of change, to see how positive impulses can be harnessed, negative ones sidetracked . . ." Mr. Goetze is a member of the Research Department of the Boston Redevelopment Authority.

A year ago **Gene Milgram,** M.C.P.'75, resigned his job in research at the University of Winnipeg and set out to travel across Canada and the U.S., mostly backpacking. That accomplished, he's set out on yet another adventure: working on arson reduction with the New York State Office of Fire Prevention and Control.

J. Mark Davidson Schuster, Ph.D.'79, is now working in the Research Division of the French Ministry of Culture and Communication, Paris, under a postdoctoral fellowship from the U.S.-France Exchange of Scientists. . . . **Mary Breuer,** M.C.P.'72, is manager — corporate planning for the Seven-Up Co. . . . **Michael L. Seltz,** M.C.P.67, has been elected associate partner of Skidmore Owings and Merrill (Washington, D.C., office).

XII
Earth and Planetary Sciences

Hatten S. Yoder, Ph.D. '48, director of the Geophysical Laboratory of the Carnegie Institution in Washington, received a Golden Plate Award from the Academy of Achievement earlier this year. . . . **Farouk El-Baz,** a former graduate student from Egypt, is now working at the Smithsonian Institution's Air and Space Museum, and is also personal science adviser to Egyptian President Anwar Sadat. As director of the Center for Earth and Planetary Sciences, the museum's research branch, he is pursuing his primary geological interest, deserts, which make up about 20 per cent of the land surface of the earth. El-Baz was

Searching for water in Australia. *Keeva Vozoff, Ph.D.'56, professor of geophysics at Macquarie University in Sydney, Australia, is turning to the "scientific divining rod" he's holding in the picture. It's an ultra-sensitive detector of electromagnetic waves, designed to indicate the presence of water in the earth by showing variations in conductivity. (Photo: John Tanner, Australian Information Service)*

Water-Cooled Mines

The temperature of the rock in the typical South African gold mine below the earth's surface is about 38° C.; in the deepest mines that rises to 47° C., and as mines have been cut ever deeper the average temperature of the virgin rock being removed has been rising about 0.5° C. a year for more than a decade.

Refrigeration to make working conditions tolerable for the 300,000 South African laborers who work underground is a major expense of mining; the goal is to achieve wet-bulb temperatures of less than 28° C.; working at more than 33° C. (wet-bulb temperature) "is not possible without severe risk of heat stroke," says the South African Chamber of Mines. Cooling plants using 250 megawatts of power are now in place, but as mines go even deeper it's been a losing battle for traditional methods of ventilating and cooling.

Studying this issue, **Austin Whillier,** Sc.D. '53, Director of the Chamber of Mines's Environment Engineering Laboratory, realized that one potential source of cooling was being overlooked. It turns out that to mine a ton of gold ore requires from 0.5 to 2 tons of water. In conventional gold mining, this water is used at the temperature the subject of a recent profile by Constance Holden in the September 28 issue of *Science*.

Stephen E. Foster, S.M. '73, was transferred in June to Union Oil Company's Stavanger, Norway, office from headquarters in Los Angeles, and is now acting as geophysical coordinator for Union's exploration activities in the Norwegian North Sea. . . . **Gerald L. Schroeder,** S.B. '59, S.M. '61, Ph.D. '64, who is employed at the Ministry of Agriculture in Israel, has been working with Southeast Asian farmers to obtain more animal protein and a larger income by converting 10 percent of their rice paddies into duck and fish ponds, thereby combining aquaculture with traditional agriculture. — **Robert R. Shrock,** professor emeritus, M.I.T. Room 54-1026, Cambridge, MA 02139.

XIII

Ocean Engineering

Captain **Harold R. Young,** U.S.N., S.M.'60, who has been production officer of the Portsmouth Naval Shipyard since 1976, is now commander of that facility. . . . Meanwhile, Captain **Vernon C. Honsinger,** N.E.'62, has been transferred from Portsmouth, where he was planning officer, to New London, Conn., where he is officer in charge of the New London Laboratory of the Naval Underwater Systems Center. . . . Commander **Lawrence K. Donovan,** U.S.N., S.M.'71, is project manager for the construction of Navy facilities on the island of Diego Garcia in the Indian Ocean.

John R. Mittleman, S.M.'70, now provides consulting services in underwater nondestructive testing at Marine Inspection Technology, Inc. . . . Vice Admiral **C. R. Bryan,** U.S.N., N.E.'52, commander of the Naval Sea Systems Command, is president of the American Society of Naval Engineers for a two-year term ending in 1981. . . . A new director of American District Telegraph Co.: **Frank J. Graziano,** S.M.'45, president and chief executive officer of Crompton and Knowles Corp. . . . **James A. Bortner,** U.S.N.(Ret), N.E.'56, is assistant professor of electronic technology at Chesapeake College, Wye Mills, Md.

Two changes reported by the Coast Guard: Lieutenant Commander **Ronald A. Marcolini,** S.M.'75, has reported for duty at Coast Guard Headquarters, Washington, D.C.; and Commander **Leonard J. Pichini,** N.E.'67, has completed the service's Senior Officer Leadership and Management School. . . . Lieutenant Commander **William R. Johanek,** S.M.'74, spent the summer as the engineering officer assigned to the cutter *Munro* on fisheries patrol in Alaska; the ship participated in two search-and-rescue missions.

XV

Management

Erskine N. White, Jr., S.M. '49, was recently elected Executive Vice President of Textron Inc., in Providence, Rhode Island. . . . **Howard A. Mandelbaum,** S.M. '65, has been appointed Senior Vice President of William Douglas McAdams Inc., in New York City. . . . **Arthur Gerstenfeld,** PhD. '66, recently gave a seminar at Worcester Polytechnic Institute on "R & D Management for Improved Productivity and Profitability" . . . **Paul R. Freshwater,** S.M. '68, writes that he has been appointed to the Board of Directors of the Charter Committee of Greater Cincinnati and Secretary of the Columbia Township Citizens Advisory Committee. . . . **Ludo F. Gelders,** S.M. '72, has been appointed as Professor of Management Science at Kathrlieke University Leuven in Belgium and Vice President of the Belgian Operations Research Society. . . . **Alan M. Cody,** S.M. '74, recently resigned from Data Resources Inc. to become Vice President of a new business consulting firm to be called Planning Economics Group in Boston. . . . **Sylvain Asser,** S.M. '74, is now a technical counselor at the "Direction Regionale de l'Equipement d'Ile de France". . . . **John D. Proctor,** S.M. '73, was recently elected Vice President and Treasurer of the Stanley M. Proctor Company. In his new position he becomes the chief financial officer of the company. He is also Treasurer and Director of the M.I.T. Club of Cleveland. . . . Dr. **David R. Meredith,** PhD '66, has been promoted from President to Chairman of Meredith Associates in Westport, Connecticut. **Chris Bullen,** S.M. '76, our west coast office of C.I.S.R., had a baby girl on October 18th. Her name is Valerie Christine. Both mother and daughter are doing well!

Sloan Fellows in the news include: **William H. Anderson,** S.M. '52, who was appointed President, Chief Executive Officer and Director of the Advent Corporation in Cambridge. . . . **Dr. Theodore F. Gautschi,** S.M. '57, an Associate Professor of Management at Bryant College has recently had a collection of his writings published by Ginn and Company in a book entitled Management Forum. . . . **Robert S. Ames,** S.M. '54, was elected Executive Vice President-Aerospace of Textron Incorporated in Providence. . . . **Alan E. Thomas,** S.M. '63, a Vice President of Southern Bell has been elected a Director of National Bank of Georgia in Atlanta. . . . **Witt I. Langstaff,** S.M. '65, has been appointed Superintendent of the Kodel Fiber Division of Eastman Kodak Chemicals Division in Kingsport, Tennessee. . . . **Robert F. Calman,** S.M. '67, was married on June 9th to Dr. Doris S. Bitman who was Director of Health Services at Smith College. Mr. Calman is Vice Chairman of the Board of Directors of IU International Corporation. . . . **Tom H. Barrett,** S.M. '69, was elected a Director of Goodyear Tire & Rubber Company in Akron. . . . **Carroll G. Tompson,** S.M. '69, has been elected Vice President and a member of the Board of Directors of R.J. Reynolds Tobacco Company in Winston-Salem. . . . **Katherine Magrath,** S.M. '76, has been appointed as Director of Equity Investments of the Ford Foundation in New York City . . . **John D. Sorrell,** S.M. '78, has been elected Secretary of the Insurance Company of North America, a subsidiary of INA Corporation in Philadelphia. . . . **Richard J. Santagati,** S.M. '79, has been named General Manager — Business Sales by New England Telephone. He will be responsible for all business telephone equipment and service sales in the commercial, government, education and medical sectors of the business market in New England. . . .

Several Senior Executives appeared in the news recently. **Robert A. Winslow,** '57, was elected President of Exxon Enterprises, Inc., the parent company's new venture affiliate. . . . **Richard L. Terrell,** '58, was elected a Director of Missouri Pacific Corporation in St. Louis. . . . **Richard D. Spence,** '62, has been elected to the Board of Directors of the Citizens Fidelity Bank and Trust Company in Louisville. . . . **Joseph A. Baute,** '64, has been selected to serve on the new Board of Directors for The New England Council, Incorporated in Boston. . . . **George R. Armstrong,** '66, was elected a Director of the Caterpillar Tractor Company in Peoria, Illinois. . . . **Wayne E. Petersen,** '72, was elected Vice President of the residential group of Honeywell Inc., in Minneapolis. . . . **John O'Brien,** '66, was elected Executive Vice President and member of the Board of Directors of Grumman Aerospace Corporation. . . . **Howard W. Blauvelt,** '56, was elected Chairman and Chief Executive Officer of the Continental Oil Company last spring. . . . **Powell A Joyner,** '67, was appointed Vice President of Research at the Trane Company in LaCrosse, Wisconsin, a manufacturer of air-conditioning and heating equipment. — **Leigh Chapman** S.M. '78, Manager of External Relations, Sloan School of Management, Room E52-402, Cambridge, Mass. 02139.

XVI

Aeronautics and Astronautics

Thomas A. McMahon, Ph.D.'70, professor of applied mechanics and biology at Harvard, has done it again — a second novel, *McKay's Bees* (Harper and Row, 1979, $8.95), about the westward migration of Gordon McKay from Massachu-

setts to Kansas by way of New Orleans and a wide variety of adventures. . . . Another author: **William H. Cullin,** S.M.'47, but his work is different — *How To Conduct Foreign Military Sales – the 1978-79 U.S. Guide,* described as "the only complete reference work on the complicated and dynamic environment of foreign military sales.

Mel L. Suarez, S.M.'77, writes that he "continues at Draper Laboratory doing analysis on the stellar-aided inertial guidance system designed by the Laboratory and used in the Trident missile." He's one of several lecturers giving a two-day course on the system to contractors involved in its manufacture.

Two academics on leaves of absence: **John Hovorka,** Sc.D.'61, professor of physics at Curry College, is a faculty fellow at the U.S. Department of Transportation; and **Robert K. Wattson, Jr.,** S.M.'48, is at Gates Learjet Corp., Wichita, from Tri-State University where he is professor of mechanical and aeronautical engineering.

Amos Levin, Ph.D.'69, formerly with Eastern Gas and Fuel Associates, is now staff vice president — financial planning and control at M/A-COM, Inc., Burlington, Mass. The firm — it used to be called Microwave Associates, Inc. — is a leading supplier of equipment and systems for telecommunications.

XVIII

Mathematics

Beginning in 1980, **Patrick C. Fischer,** Ph.D.'62, will be chairman of the Department of Computer Science at Vanderbilt University; he's moving to Nashville from Pennsylvania State University, where he's been professor of computer science. Mrs. Fischer, who's held a similar post at Penn State, will also join the Vanderbilt faculty. . . . **Douglas A. Szper,** assistant actuary with the State Mutual Life Assurance Co., Worcester, Mass., has been named a fellow of the Society of Actuaries. . . . **Michael Zuker,** Ph.D.'74, has been granted a permanent (tenure) position in the Biomathematics Section of the National Research Council of Canada, Ottawa.

To celebrate the 60th birthday of Professor **Irving E. Segal,** the department was host in October to a conference on the four areas in which Professor Segal has himself made major advances: harmonic analysis and operator algebras, functional integration and the mathematical theory of quantum fields; non-linear evolutionary partial differential equations; and fundamental physics. We welcomed some 70 scientists and mathematicians, including many former students, for a program including papers by 12 of Professor Segal's co-workers and colleagues.

XXII

Nuclear Engineering

Brian G. Schultz, S.M.'66, reports from his post as Stone and Webster's project manager for the River Bend nuclear power station: it is the first nuclear plant being built under the National Nuclear Stabilization Agreement, and construction work is proceeding on schedule on an alternating-shift basis, four days per shift, ten hours per day — a work week of 70 hours.

Lieutenant **Mark J. Harper,** U.S.N., S.M.'76, is now weapons officer aboard the *U.S.S. Lapon,* a nuclear-powered fast attack submarine whose home base is Norfolk, Va. . . . **Achilles G. Adamantiades,** Ph.D.'66, has been transferred from Washington, where he was with the Nuclear Division of the Electric Power Research Institute, to Palo Alto; there, at E.P.R.I.'s headquarters, he's planning manager in the Department of Nuclear Safety and Analysis. . . . **Daniel R. Raichel,** S.M.'58, has joined Harland Bartholomew and Associates, Inc., St. Louis, as director of its Acoustic and Noise Control Group; the firm does pianning, engineering, landscape architecture, and environmental science. Dr. Raichel also serves as adjunct professor of mechanical engineering at New Jersey Institute of Technology.

of the rock through which it flowed. Now that's changing: Dr. Whillier's system turns this water into a cooling as well as mining agent by refrigerating it before use. He thinks it will permit mining rocks as hot as 60° C.

Savings to the industry will amount to nearly $20 million annually when Dr. Whillier's new system is in place in the 26 major mines which are now planning to use it.

With the Alumnae

Bertha Dodge '22, has published a book with the Wesleyan University Press which accounts an American sailing captain's experience of being marooned on the Falkland Islands during the War of 1812. Bertha will also soon see in print another manuscript on plants and their impact on human affairs during the centuries. **Lisa Rosenbaum '78,** also has recently edited and published a book, *Lynn Harbor: Planning the Coastal Development.*

Catherine C. Lindsay, '76, is presently working in London for the Carborundum Overseas Corporation. She is personnel planning and control manager for Europe, Africa, and the Middle East.

Among the officers of the M.I.T. Club of Southern California is **Esmerelda M. Vallejo, '78,** who is vice president for public relations. She is also an instructor at the Los Angeles Community College.

Mata Frondistou-Yannas, '73, is very busy being both vice president of the Business and Economics Institute in Lexington, Mass., and adjunct assistant professor of operational management at Boston University's School of Management. **Barbara D. Putnam, '77,** an architectural designer at Total Environment Action in Harrisville, N.H., is building her own house in Harrisville with an all-women crew. She hopes to have completed the house by Christmas.

Barbara Feeney Powers, '49, became the only woman public high school principal in Vermont when she took over at Champlain Valley Union High School. Barbara has her Ph.D. from the University of Wisconsin, and was one of 208 applicants for the job.

Congratulations to the following alumnae whose children or siblings have arrived at M.I.T. with the entering Class of 1983: **Caroline DiSario, '56,** and **Helen Chihoski, '79, Linda G. Sprague, '61, Wendy L. Wolfe, '78, Mary Ellen O. Conway, '70,** and **Claude E. Owre, '73,** and last but not least, **Marie M. Wray, '59,** (whose husband and son also precede daughter Christine at M.I.T.). In addition, the following M.I.T. alumni have sent their daughters to the Institute this year: **Raymond Ambrogi, '60,** (Lisa), **Richard W. Bloomstein, '57,** (Joanne), **Terrance M. Carney, '56,** (Laurel), **Robert Cawley, '65,** (Elise), **Spencer L. Commerford, '51,** (Janine), **William Delaney, '59,** (Maureen), **Yung Ko, '58,** (Anne), **Richard Lyle, '52,** (Marilee), **James Melcher, '61,** (Jennifer), **Walter Rotman, '47,** (Ruth), **Case K. Tong, '70,** (Doremy), and **Leonard Vaughn, '60,** (Robin). These men are pioneers in continuing the alumni traditions through their daughters.

C. R. Bryan

AMITA hopes to arrange another weekend at Talbot House, M.I.T.'s farmhouse in Woodstock, Vt. Three years ago, AMITA arranged for a weekend there and a good time was had by all. If you are interested, please contact Sandy Yulke, '74, 167 Charlton St., Arlington, Mass. 02174; or by telephone (617) 648-0969. The type of meeting will be determined by your preferences, so let Sandy know whether you prefer a weekend with alumnae only, alumnae and students, or alumnae with families and/or children. This is a good opportunity for people in the Northeast region who can't attend the regular Boston area meetings to get together with other alumnae.

Any woman who did not receive a copy of the AMITA Fall Newsletter (which was sent to alumnae on the Alumni Association's records), please contact Paul Johnson at the Alumni Center (617-253-8240). Paul has recently assumed the regional directorship for New England, and will also work with AMITA. Paul replaces Bob Blake, who as regional director for the West, hopes to build an active network of women in the western U.S. — *Elizabeth A. Greene.*

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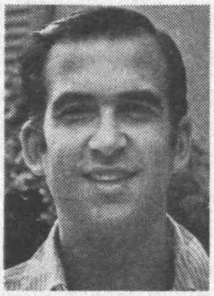
Puzzle Corner
Allan J. Gottlieb

The Annual Anniversary Problem for 1980



Allan Gottlieb is associate professor of mathematics at York College of the City University of New York; he studied mathematics at M.I.T. and Brandeis. Send problems, solutions, and comments to him at the Department of Mathematics, York College, Jamaica, N.Y. 11451.

As this is written, I've just returned from the national conference of the Association for Computing Machinery at which the North American Computer Chess Championship was held. Last year's champion, BELLE, designed by Ken Thompson and Joe Condon of Bell Telephone Laboratories, was defeated by CHESS 4.9, the work of Larry Atkin and David Slate of Northwestern University. The top four programs were nearly equal in strength and played very fine chess (I would say they are of "expert" caliber). But a potentially even bigger story is the rapidly growing strength of microcomputer chess programs. Very soon you will be able to purchase chess machines that play high "B" level chess, good enough to beat most amateurs.

Problems

Y1980 This being the first issue for the new year, we begin with our yearly problem: form as many as possible of the integers from 1 to 100 using the digits 1, 9, 8, and 0 exactly once each and the operators +, −, * (multiply), / (divide), and ** (exponentiation). We desire solutions containing the minimum number of operators; and, for a given number of operators, solutions using the digits in the order 1, 9, 8, and 0 are preferred. The solution to Y1979 is given below.

D/J 1 Our first regular problem is from Gary Schwartz; he attributes it to *District 4 Spot.* The goal is for South, on lead, to win all eight remaining tricks.

	♠A 6 ♥K 10 5 2 ♦6	
♠K J ♥9 8 7 6 ♦4 ♣2	♣4	♠ Q 10 ♥ K Q 4 3 ♦ 5 3 ♣ —
	♠3 2 ♥A ♦2 ♣A 10 6 3	

[**D/J 1a** As you have discovered by now, the trump suit was not specified. What should it be to make **D/J 1** a good problem? — **Ed.**]

D/J 2 Frank Rubin offers us two cryptarithmetic problems. In each one you are to replace each letter by a different decimal digit to make the arithmetic correct.

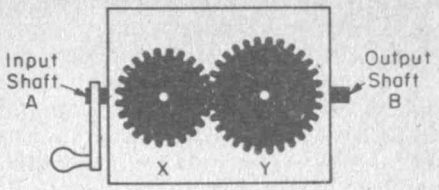
W H I T E x X = G R E E N

G R E E N x X = B L A C K

Note that the two problems are *not* related.

D/J 3 The following problem first appeared in *Technology Review* in 1940 as part of an advertisement for Calibron products:

The diagram represents a box from which two keyed shafts project toward the reader. With gears X and Y on these shafts as shown, there is a true drive connection between input shaft A and output shaft B, but if



the gears are interchanged shafts A and B can be turned independently. The box contains nothing but ordinary gears, shafts, and bearings. What is the mechanism?

D/J 4 Harry Zaremba has submitted a problem involving nested series: (I peeked at his solution and can report that it is quite nice.) Find the sum of the following series of terms for any positive integer m:

$S(m) = 1^3 + 2^3(1^3 + 3^3)$
$+ 3^3(1^3 + 3^3 + 5^3) + \ldots$
$\ldots + m^3[1^3 + 3^3 + 5^3 + \ldots + (2m-1)^3]$; or

$$S(m) = \sum_{n=1}^{m} n^3\left[\sum_{i=1}^{n}(2i-1)^3\right].$$

D/J 5 We close with a calculator problem from Alan LeVergne, which he says arose from and is equivalent to the question of which powers could be computed on a direct-algebraic-notation calculator using parentheses but not numerical keys, memory, or logarithm-based exponentiation keys. For instance, the seventh power of a number in the x register can be calculated by the sequence: ÷, x^2, x^2, x^2, x⟷y =.

We define the following operations on ordered triples (A,B,C) of positive real numbers.

Mult:	(A,B,C)	⟶ (AxB, O, C)
Div:	(A,B,C)	⟶ (A÷B, O, C)
Load:	(A,B,C)	⟶ (A, A, C)
SQ:	(A,B,C)	⟶ (A^2, B, C)
LP:	(A,B,C)	⟶ (A, A, A)
RP:	(A,B,C)	⟶ (A, C, O)

Say n is admissible if for all z > o, (z^n, o, o) can be obtained from (z, o, o) by fixed (not depending on z) sequence of the above operations. For instance, the algorithm for N = 7 is LOAD, SQ, SQ, SQ, Div. The problem is to find the smallest nonadmissible integer. I think the solver will be surprised at how much can be accomplished with such a small set of simple operations; I was.

Speed Dept.

D/J SD1 Ed Lynch has sent us an international problem:

If these sequences of numbers appeared in the following countries, what would they have in common?

Germany	2-10-4-7-6-9-5-1-3-8
France	1- 3-6-7-4-9-8-10-2-5
England	2-3-10-6-7-1-9-4-5-8

D/J SD2 Charles Heiberg sent us this "speed" problem for people with nondigital watches: Precisely, what is the first time after midnight when the hour and minute hands of the clock coincide?

Solutions

Y1979 Form as many as possible of the integers from 1 to 100 using the digits 1, 9, 7, and 9 exactly once each and the operators +, −, * (multiply), / (divide), and ** (exponentiation). The best solution contains the minimum number of operators and — for a given number of operators — uses the digits in the order 1, 9, 7, and 9.

As one would expect, the duplicate 9s caused this to be a difficult yearly problem. Apparently 33 of the 100 numbers cannot be formed. (Let me remind everyone that a solution with two operators and the digits out of order is preferred over one with three operators and the digits in order.) The following is from Lou Cesa:

1.	1**979	51.	
2.	(1**9)* 9 − 7	52.	
3.	19 − 7 − 9	53.	71 − 9 − 9
4.	(19 + 9)/7	54.	(1 * 9 * 7) − 9
5.	(1 + 9)/(9−7)	55.	(1−9) + (7*9)
6.	97 − 91	56.	(9 − (1**9))*7
7.	(1**99)*7	57.	
8.	(1**99) − 7	58.	
9.	(1**97)*9	59.	
10.	(1**97)+9	60.	79 − 19
11.	(1*9)−7+9	61.	((1+9)*7)−9
12.	91 − 79	62.	(9*7) − (1**9)
13.		63.	(1**9)*7*9
14.	(99−1)/7	64.	(9*9) − 17
15.	9 − (1**9)+7	65.	((9−1)*7)+9
16.	17 − (9/9)	66.	
17.	19−7−9	67.	
18.	17+(9/9)	68.	
19.	1+((9−7)*9)	69.	79 − 1 − 9
20.	(1+9) * (9−7)	70.	(19−9)*7
21.	19−7−9	71.	1 − 9 + 79
22.	(91/7)−9	72.	(17−9)*9
23.		73.	1+9+(7*9)
24.	9−1+7+9	74.	(1*9*9)×7
25.	(1*9)+7+9	75.	91−7−9
26.	1+9+7+9	76.	
27.	(1+9−7)*9	77.	
28.	99−71	78.	97 −19
29.		79.	(1**9)*79
30.		80.	(1**9)+79
31.		81.	(1/9)**(7−9)
32.		82.	99 − 17
33.		83.	((1+9)*9)−7
34.		84.	
35.	19+7+9	85.	
36.		86.	
37.		87.	9 − 1 +79
38.	19*(9−7)	88.	1*9+79
39.		89.	1+9−79
40.		90.	((1**7)+9)*9
41.		91.	99 − 1 − 7
42.		92.	(1*99)−7
43.		93.	1 + 99 −7
44.	(9*7)−19	94.	
45.	(9*(7−1))−9	95.	
46.		96.	97 − (1**9)
47.	((9−1)*7)−9	97.	(1**9)*97
48.		98.	19+79
49.	7**(1+(9/9)	99.	(1**7)*99
50.		100.	(1**7)+99

Also solved by Phillip Feurwerger, Clark Baker, Tom Schonhoff, Gerald Blum, Ben Ackerman, John Rule, James Bridgeman, Winslow Hartford, Winthrop Leeds, Charles Rivers, G. Sharman, and Harry Hazard.

NS15 There are 4n tennis players who wish to play (4n + 1) doubles matches, where n is any positive integer. How can the matches be arranged so that all players play in every match with the limitation that each player plays with each other player once only and against each other player the same number of times? When n = 1 the solution is easy and quite obvious. Is there a general solution or formula or system? Is it limited to perhaps n = 5 or n = 6?

Judith Longyear attacked this using some methods from the mathematical theory of block designs. Dr. Longyear writes: Since {a, b, c, d} = ab|cd, ac|bd, ad|bc so nicely, NS15 has a solution whenever 4n = 12t + 4 and there is a resolvable design [(3t + 1)(4t + 1), 12t + 4, 4t + 1, 4, 1]. (Although Dr. Longyear does not tell us what a "resolvable" design is, she does supply examples of pairings for t = 1 and for t = 2—i.e., for 16 and 28 players. I should point out that the latter is our largest example to date and does not fit any of the sequences of values for which solutions were conjectured.)

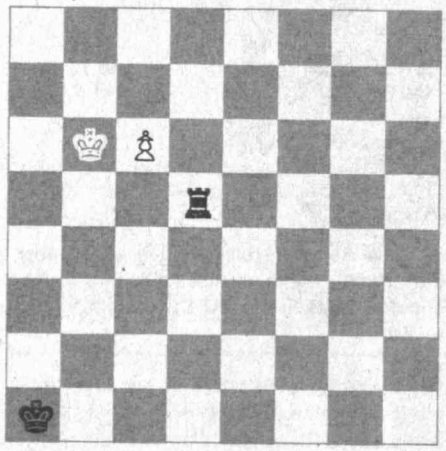
4n = 16. Name the players 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, t, e, w, r, f, and v, and arrange the matches as follows:

Court	*Days*				
	1,2,3	4,5,6	7,8,9	10,11,12	13,14,15
1	0,1,2,3	0,4,5,6	0,7,8,9	0,t,e,w	0,i,f,v
2	4,9,w,f	1,8,e,f	1,6,w,v	1,5,9,i	1,4,7,t
3	5,7,e,v	2,7,w,i	2,5,t,f	2,4,8,v	2,6,e,9
4	6,8,t,i	3,9,t,v	3,4,e,i	3,6,7,f	3,5,8,w

On days 1, 4, 7, 10, and 13 in each court pair the first and second against the third and fourth. On days 2, 5, 8, 11, and 14 pair the first and third; and on days 3, 6, 9, 12, and 15 pair the first and fourth.

4n = 28. First note that this is the first example found where n is not a power of 2. Name the 28 players $ (a money player!—*Ed.*) and all (x,y,z) where x, y, and z are 0, 1, or 2 and all additions take place module (3,3,3). Again, as shown in the table below, three days are spent with each arrangement using the same partnerships as before, where the arrangements run through the nine possibilities for (y,z), namely 00, 01, 02, 10, 11, 12, 20, 21, and 22.

A/S 1 White to play and win:



Let's begin with Robert Slater's solution at the top of the next column:

1	P—B7[1]		R—Q3 ch
2	K—N5[2]		R—Q4 ch
3	K—N4		R—Q5 ch
4	K—N3		K—N1[3]
5	P—B8 (Q)		R—Q6 ch
6	K—B5[4]		

At this point, though many variations are possible due to the mobility of the remaining pieces, White has a clear win.

[1]If K—R7, K—N7, K—B7, or K—R6, loss of pawn is inevitable.

[2]If K—R7, K—N7, or K—R5, loss of pawn is inevitable; if K—B5 and R—Q8, while pawn may be queen, loss is unavoidable.

[3]Not . . . R—Q6 (ch), which will result in queening of the pawn or loss of the rook after K—B2.

If Black actually tries 4 . . . R—Q6 (ch), White can do better than just obtaining a queen-vs.-rook ending, as shown in the following solution by Paul Debbas. Incidentally, the computer program BELLE has shown that queen vs. rook does lead to a win, but *not* easily.

1	P—B7	R—Q3 ch
2	K—N5	R—Q4 ch
3	K—N4	R—Q5 ch
4	K—N3	R—Q6 ch
5	K—B2	R—Q5
6	P—B8 (R)	R—QR5
7	K—N3	

If 7 . . . K—N8, then KxR. Any other move allows R—B1 (mate).

Also solved by Abe Schwartz, Jerome Taylor, Larry Marden, Elliot Roberts, Ron Adelsman, Adam Becker, Coran Li, Turner Gilman, Smith Turner, Jerry Grossman, Don Froemke, G. Sharman, and the proposer, Steve Grant.

A/S 2 An expedition seeking to cross a 100-mile desert can travel 20 miles in a day. However, there are no supplies in the desert, and they can only carry two days' provisions at a time (today's plus one extra day's). They can, of course, go out into the desert, deposit a day's supplies, and return to their base. Supplies are sealed in one-day packages; they cannot be broken up. What is the least number of days it will take to cross the desert? You might also try two variants: Is there a general solution for deserts of different widths? Would the answer be different if the provision against fractional days' supplies were eliminated?

Only the proposer, Charles Bahne, solved this one. His solution is 86 days, using the procedure given in the chart at the top of the next column:

Court				
1	$,	(0,y, z)	(1,y, z)	(2,y, z)
2	(0,1+y,z)	(0,2+y,z)	(1,y, 1+z)	(2,y, z)
3	(1,1+y,z)	(1,2+y,z)	(2,y, 1+z)	(2,y, 2+z)
4	(2,1+y,z)	(2,2+y,z)	(0,y 1+z)	(0,y, 2+z)
5	(0,1+y,2+z)	(1,1+y,1+z)	(0,2−y, 1+z)	(1,2+y,2+z)
6	(1,1+y,2+z)	(2,1+y,1+z)	(1,2−y, 1+z)	(2,2+y,2+z)
7	(2,1+y,2+z)	(0,1+y,1+z)	(2,2−y, 1+z)	(0,2+y,2+z)

On day(s) number	Start at mile	Do the following	Return to mile	After which supplies are stored at
1-42	0	Go to mile 10 and store one package there.	0	Two at mile 0, 42 at mile 10
43	0	Go to mile 15 and store one package there	10	42 at mile 10, one at mile 15
44-63	10	Go to mile 20 and store one package there	10	Two at mile 10, one at mile 15, and 20 at mile 20
64	10	Go to mile 20 and store one package; then go back to mile 15, pick that one up, and return to	20	22 at mile 22
65-74	20	Go to mile 30 and store one package there	20	Two at mile 20, 10 at mile 30
75	20	Go to mile 35 and store one package there	30	Ten at mile 30, one at mile 35
76-79	30	Go to mile 40 and store one package there	30	Two at mile 30, one at mile 35, and four at mile 40
80	30	Go to mile 40, store one package there, then go back to mile 35, pick that one up, and return to	40	Six at mile 40
81, 82	40	Go to mile 50 and store one package there	40	Two at mile 40, two at mile 50
83	40	Go to mile 55 and store one package there	50	Two at mile 50, one at mile 55
84	50	Go to mile 60, store one package there, then go back to mile 55, pick that one up, and return to	60	Two at mile 60
85	60	Go straight through to mile 80	80	One at mile 80
86	80	Go straight through to	100	None

A/S 3 The following are the first letters of five words of a common, ordered series having to do with numbers. For example, OTTFF is "**O**ne, **T**wo, **T**hree, **F**our, **F**ive." What are the words?

1. U T H T T
2. F S T F F
3. S D T Q Q
4. O F N S T
5. O S T S O

The first four of these are straightforward, and nearly everyone agreed that the answers are:

1. **U**nits, **T**ens, **H**undreds, **T**housands, **T**en **T**housands
2. **F**irst, **S**econd, **T**hird, **F**ourth, **F**ifth
3. **S**ingle, **D**ouble, **T**riple, **Q**uadruple, **Q**uintuple
4. **O**ne, **F**our, **N**ine, **S**ixteen, **T**wenty-five (the squares of the first five whole numbers)

For the fifth, the answers are unique. The reason for this can be found by examining the proposer's (William Hornick) solution:

5. **O**ne, **S**ix, **T**wenty-seven, **S**ixty-four, **O**ne hundred twenty-five (the cubes of the first five whole numbers)

Unfortunately, $2^3 = 8$. But this only slowed some people down momentarily. Avi Ornstein and Harry Zaremba figured out the error; Abe Schwartz hit upon:

5. **O**ne, **S**ixteen, **T**hirty-six, **S**ixteen, **O**ne (the squares of the binomial coefficients 1, 4, 6, 4, 1).

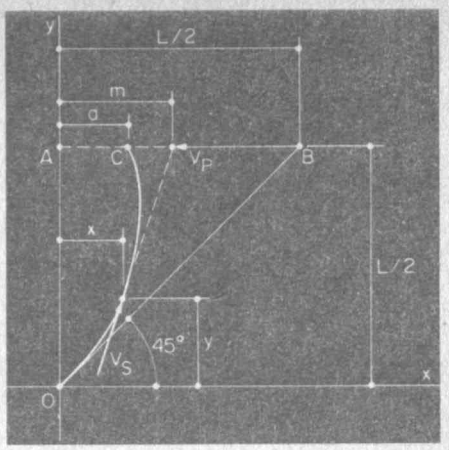
G. Sharman found a complicated method based upon adding and subtracting 6s. Winslow Hartford's solution is even less obvious. But my favorite is from James Landau, who suggests four alternatives:

5. **O**ne, **S**ix hundred twenty-five, **T**en thousand, **S**ix million two hundred fifty thousand, **O**ne hundred million (1^4, 5^4, 10^4, 50^4, 100^4); or
5. **O**ne, **S**ixteen, **T**wo hundred fifty-six, **S**ixty-five thousand five hundred thirty-six, **O**ne million forty-eight thousand five hundred seventy-six (2^0, 2^4, 2^8, 2^{16}, 2^{20}); or
5. **O**perating **S**ystem/360 with **T**ime-**S**haring **O**ption (OS/TSO, the computer system on which I work); or
5. **O**ne, **S**ix, **T**wenty-eight, and **S**o **O**n (a very sloppy list of perfect numbers).

A/S 4 A surface-to-air missile (SAM) tracks its quarry through a heat sensor in the nose. Assume that there is a large square marked off in the sky. A plane enters the square at the southeast corner at 600 m.p.h. and proceeds on a straight course to the northwest corner. At the same moment that the plane enters the square, a SAM enters the southwest corner of the square going at 1200 m.p.h. Instead of "leading" the plane to intercept it more quickly, the SAM points at the plane at all times, thus traveling in an arc as it alters direction to follow the plane. The plane is following a diagonal line. How far up this diagonal line will the plane go before it is intercepted by the SAM?

The following solution is from Harry Zaremba:

In the figure, let points O and B be the corners at which the missile and plane enter the square, respectively. Also, let



v_p = 600 m.p.h., the velocity of the plane.
v_s = 1200 m.p.h., the velocity of the missile.
m = the coordinate of plane at any instant along the diagonal.
L = the length of a diagonal of the square.
a = the coordinate of the point of interception.

From the figure, the slope of the missile's path at any instant of time is

$dy/dx = \dot{y} = (L/2 - y)/(m - x)$. (1)

If s is the distance the missile has traveled in time t, then $t = s/v_s$, and similarly the time for the plane will be $t = (\frac{1}{2}L - m)/v_p$. Equating the time intervals, we get

$s/v_s = (\frac{1}{2}L - m)/v_p$, or

$m = L/2 - v_p s/v_s = \frac{1}{2}(L - s)$.

Substituting m into equation (1) and solving for s,

$s = L - 2x + (2y - L)/\dot{y}$. (2)

Differentiating expression (2) with respect to x and simplifying,

$ds/dx = [(L - 2y)\ddot{y}]/\dot{y}^2$. (3)

Since $ds/dx = (1 + \dot{y}^2)^{\frac{1}{2}}$, then equation (3) equals

$(1 + \dot{y}^2)^{\frac{1}{2}} = (L - 2y)\ddot{y}/\dot{y}^2$. (4)

If we let $\dot{y} = p$, then

$\ddot{y} = dp/dx = dp/dy \cdot dy/dx = p(dp/dy)$.

Substituting $\dot{y}$ and $\ddot{y}$ into (4) and separating variables,

$dp/p(1 + p^2)^{\frac{1}{2}} = dy/(L - 2y)$.

Integrating, and noting that p = 1 when y = O, the equation of the slope to the missile's path becomes,

$(\sqrt{p^2 + 1} - 1)/p \cdot (L - 2y)^{\frac{1}{2}}$
$\leftarrow (\sqrt{2} - 1)\sqrt{L}$. (5)

Substituting p = dy/dx into (5), squaring, integrating, and noting that y = O when x = O, the solution to (5) becomes

$\sqrt{L - 2y}/3(\sqrt{2} - 1)\sqrt{L} \cdot$
$[y + (4 - 3\sqrt{2})L] = x - (2 - \sqrt{2})L/3$, (6)

which is the equation for the path of the missile. At the point of interception, x = m = a and y = L/2. Thus, from equation (6) we get

$a = (2 - \sqrt{2})L/3$.

Referring to the figure, the distance traveled by the plane to the point of interception is

$BC = L/2 - a = L/2 - (2 - \sqrt{2})L/3$, or

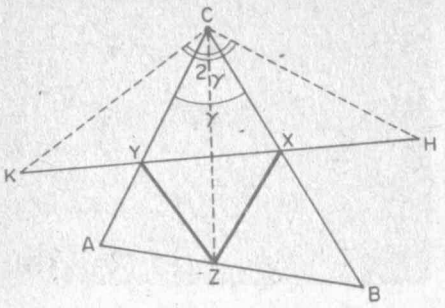
$BC = (2\sqrt{2} - 1)L/6 = 0.3047L$.

Also solved by Emmet Duffy, who submitted the published solution to the related hummingbird problem which was published in 1974.

A/S 5 Given an acute-angled triangle, find the inscribed triangle having minimal

perimeter.

The following solution is from the proposer, Emmet Duffy: Let the given triangle be *ABC* and let *XYZ* be a triangle inscribed in it, with *X*, *Y*, and *Z* on *BC*, *CA*, and *AB*,



respectively. We will initially consider that *Z* is arbitrarily situated on *AB*; we draw its mirror images *H* and *K* on *BC* and *CA*, respectively, and determine the points of intersection *X* and *Y* of the connecting line *HK* with *BC* and *CA*. For a *fixed* point *Z* the triangle *XYZ* thus formed has the smallest perimeter of all the inscribed triangles. In fact: let *X'* and *Y'* be two other points on *BC* and *CA*. Since *ZX'* and *HX'* are mirror images, and also *ZY'* and *KY'*, and naturally also *ZX* and *HX*, as well as *ZY* and *KY*, the perimeters of the two inscribed triangles to be compared can be written as

$ZXYZ = HX + XY + YK = HK,$

$ZX'Y'Z = HX' + X'Y' + Y'K = HX'Y'K.$

However, since the direct path *HK* from *H* to *K* is shorter than the roundabout path *HX'Y'K*, the first triangle possesses a smaller perimeter than the second. It now merely remains to choose the point *Z* in such manner as to obtain the smallest possible segment *HK* (which represents the perimeter of *XYZ*). Now *CZ* is the mirror image of *CH* and also of *CK*; likewise, $\measuredangle ZCB = \measuredangle HCB$ and $\measuredangle ZCA = \measuredangle KCA$ and thus $\measuredangle HCK = 2\gamma$. Segment *HK* is therefore the base of an isosceles triangle *(HKC)* with a constant apex angle 2γ and the variable leg $s = CZ$; as such it attains a minimum when *CZ* is at a minimum, i.e., when *CZ* is perpendicular to *AB*. Since we could just as easily have carried out the investigation with *X* or *Y* as with *Z*, *AX* is perpendicular to *BC* and *BY* to *CA*. The points *X*, *Y*, *Z* are thus the base points of the altitudes of the triangle *ABC*.

Result: Of all the triangles that can be inscribed in a given acute-angled triangle, the one with the smallest perimeter is the triangle formed by the base points of the altitudes.

Better Late Than Never

1978 A/S 4 Emmet Duffy and an IBM 370 have found three five-digit numbers each satisfying the condition that the sum of the fifth powers of the digits gives the number itself. The numbers are 54,748, 92,727, and 93,084.

1978 D/J 3 Tsvi Ophir has responded.

1979 FEB 1 D. Sweeney notes that the Knight's tour can be solved as a traveling salesman problem. In 1963 he wrote a master's thesis at M.I.T. on this problem which I read a dozen years later when I worked on the same problem.

M/A 3 Tsvi Ophir has responded.

M/A 5 Emmet Duffy notes that the ratio of his implicit solution and the proposer's explicit solution is always near one. Meanwhile, the proposer has withdrawn his explicit solution.

MAY 4 James Landau notes that in the denominator of his continued fraction, "b" should be "2b"; also $b < x < 2b$ should be $b < \sqrt{x} < 2b$. In addition, he enclosed a revised typewritten version of the analysis mentioned in the published solution. Anyone desiring a copy should write to the editor.

J/J 3 Leigh Walzer has responded.

J/J 4 P. Jung has responded.

Proposers' Solutions to Speed Problems

D/J SD 1 The numbers from 1 to 10 written in reverse alphabetical order.

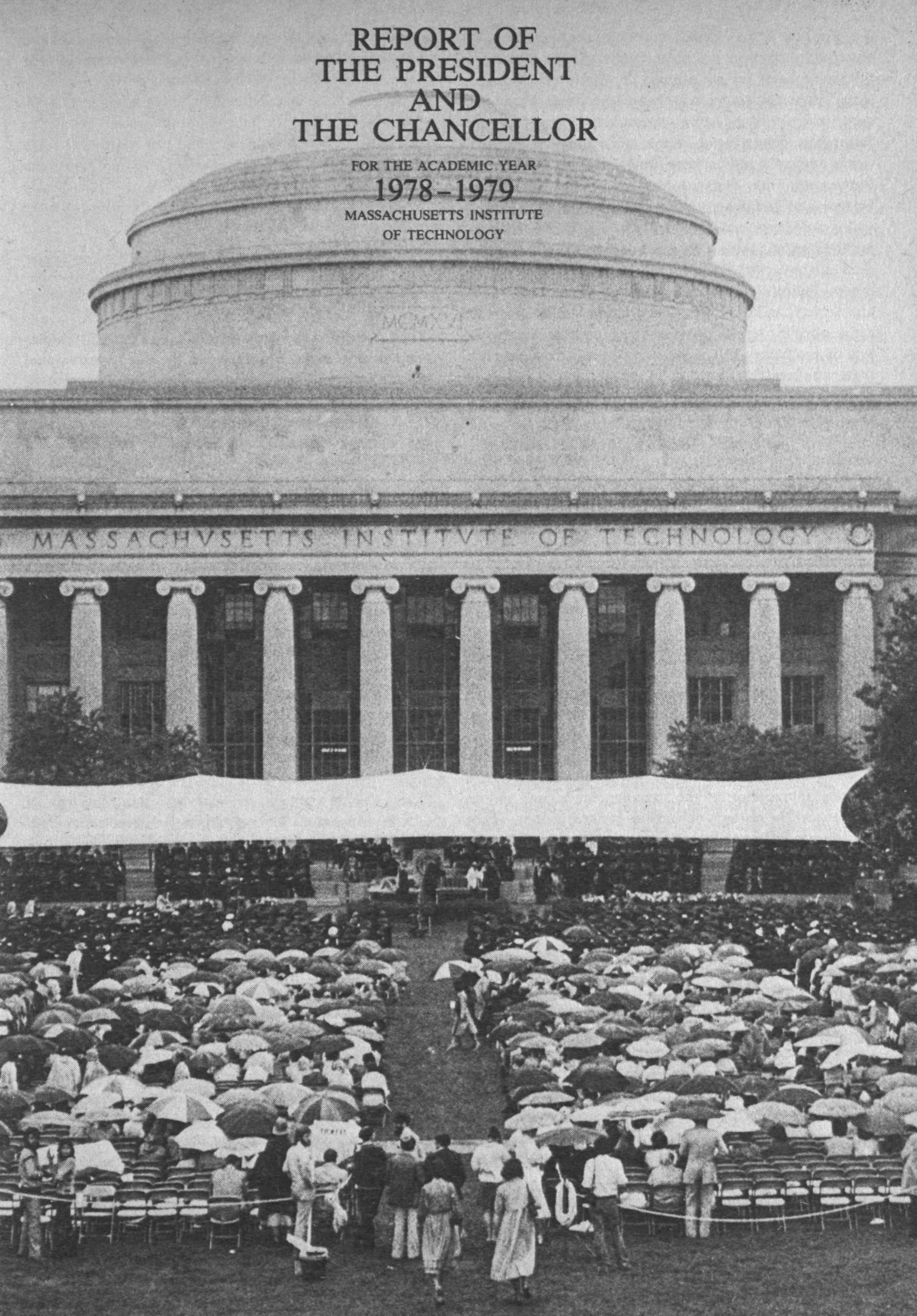
D/J SD 2 From the fact that the hour and minute hands coincide at eleven evenly distributed locations, it follows that the solution is 5-5/11 minutes after 1 p.m.

REPORT OF THE PRESIDENT AND THE CHANCELLOR

FOR THE ACADEMIC YEAR

1978–1979

MASSACHUSETTS INSTITUTE
OF TECHNOLOGY



The year just completed was one of considerable movement and excitement on many fronts. As the Leadership Campaign nears its completion, its effects are evident in many ways: the traditional departmental and disciplinary activities are receiving added support in the form of new professorships, more adequate space, new equipment, and additional academic and research funds; the maturing Energy Laboratory, the Harvard-M.I.T. Division of Health Sciences and Technology, and many other programs are providing widespread support for faculty and students throughout the Institute; there is the rapid development of programs (and in many cases, facilities) for the Whitaker College, the Plasma Fusion Center, the Program in Science, Technology, and Society, and the Energy Laboratory; and we are in the active planning stages for several new interdisciplinary centers or programs. This sense of movement comes as well from imminent construction of sorely needed and long-planned new dormitory and athletic facilities.

The ferment and dynamic nature of the Institute were reflected on the student front this year as we reviewed the organization of student services and, in the process, asked questions about our institutional responsibilities which extend beyond the formal curricular offerings to the provision of a supportive environment for all of our students.

The year marks as well a special milestone in the educational life of the Institute — the tenth anniversary of the Undergraduate Research Opportunities Program, the remarkably successful innovation in the learning encounter between teacher and student.

We have been pleased too by considerable progress in our relationships with funding agencies, as evidenced by a number of actions during the past year. Signs of this improving relationship can be seen in the responsiveness of various Federal agencies and the committees of Congress to the difficulties posed by policy changes regarding fiscal responsibility in Federal relationships. More importantly, we sense a growing appreciation of the structure, needs, and serious problems of the research universities by these groups, whose sympathetic understanding and support is so essential to the well-being and vitality of the research universities in general, and of M.I.T. in particular.

In April we completed the fourth year of the Leadership Campaign. At the close of the 1978–79 academic year on June 30, the Campaign total was $215 million. As we write this report the total has exceeded $220 million, very near the Campaign goal of $225 million. It is clear that we shall make our target, thanks to M.I.T.'s friends and supporters, especially those in the M.I.T. Corporation and the Corporation Development Committee. Unfortunately, the relentless pace of inflation makes it impossible to meet all of the objectives which this sum originally encompassed, and even at the start it represented an estimate of our fund-raising capacity, not the Institute's true need. Finding additional support for faculty members, students, and desired facilities must remain one of our major efforts.

In 1975, at the beginning of the Leadership Campaign, we said that our purpose was to provide facilities, talent, and support that would "make it possible for M.I.T. to address more effectively through teaching and research, and socio-technological dilemmas now confronting the nation and the world — to scale its contributions to the needs and opportunities appropriate for today and tomorrow." The degree to which this has actually occurred can be seen in many specific programs, but it is even more apparent if one examines, as we shall do here, the contributions of the Leadership Campaign to the continuing evolution of the intellectual map of M.I.T. and its congruence with the vital problems of American society.

THE EVOLVING INTELLECTUAL MAP OF M.I.T.

As we write this report at the close of the 1970s, it seems that a brief look at the Institute over the past 50 years would provide an appropriate introduction to our discussion of M.I.T. today.

The depression that began in 1929 was the most severe this country has seen, and the half century that has elapsed since then has been marked by political cataclysms. At the same time, this period has been both a golden era in the natural sciences and related technologies, and one in which these areas have become matters of serious public concern. These years also coincide with the emergence and the maturing of M.I.T. as a leading international university with a scope that mirrors the nature of contemporary society, and with special emphasis upon science and technology. This evolution dates back to the assumption of the M.I.T. presidency by Karl T. Compton in 1930: his vision made what followed possible.

It is clearly not possible in this report to detail the changes that have taken place in science and engineering or, indeed, the changes in M.I.T. that this half century has seen. The most we can do is to contrast in a few broad brushstrokes this landscape as it appeared in 1930 and as it is today, and to highlight certain events along the way. In selecting dimensions for comparison, we chose certain indicators relevant to M.I.T.'s purposes and goals — milestones in the natural sciences and engineering fields which, while not reflecting all of M.I.T.'s endeavors, are close to the heart of the institution.

In the natural sciences, an enumeration of some of the Nobel Prizes that were awarded during the early 1930s will give some idea of the major trends at that time. Quantum mechanics had just come onto the scene and it was thus no accident that the Nobel Prize for Physics in 1932 was given to Heisenberg and in 1933 to Dirac and Schrödinger. The Nobel Prize for Physics in 1935 recognized the discovery of the neutron by Chadwick, a landmark in the history of atomic structue. In Chemistry, Harold Urey was awarded the Prize in 1934 for the discovery of heavy hydrogen, and the Curies received it in 1935 for the synthesis of new radioactive elements. In Physiology and Medicine, the 1930 Prize went to Landsteiner for discovery of blood groups; the 1932 Prize went to Sherrington and Adrian for discoveries of the function of the neuron; and the 1933 Prize went to Thomas

Karl Taylor Compton, whose emphasis on fundamental science and research influenced the direction and shape of M.I.T. today, served as president of the Institute from 1930 to 1949.

Morgan for his work on the hereditary function of the chromosome. These prizes reflect much of what came to be the classical textbook material of our youth.

While the Nobel Prizes give us some limited idea of the major intellectual thrusts in the natural sciences, they fail to present a picture of the remarkable exploits of engineering of that period: the great bridges, the airplanes, the advent of air conditioning, the electrical machines, and the great dams that characterized that epoch. The various fields of engineering reflected rather closely relevant industrial practice of the time, and in their relation to the physical sciences, they differed strikingly from the contemporary technologies.

One illustration of the perception of engineering education in relation to basic science can be found in Karl Compton's own description of a conversation he had when he received the invitation to become President of M.I.T.:

I was not too sure I wanted to be President of M.I.T. I wanted to think it over and talk it over with Frank B. Jewett, President of Bell Laboratories, and made an appointment to see him. As I left the house that morning, I told my wife that I was pretty sure I would turn the job down, and in fact Dr. Jewett did nothing positive to try to influence me. He said that he had observed some things about engineering schools in the United States; they had performed a useful function several decades ago and had done a marvelous job in his opinion but were far behind in their usefulness in the present and particularly in any future. They were too much on the pattern of technical trade schools. The only solution was to try to inject into the politics of these institutions a greater interest in fundamental science and research if someone could be found to do it. So I thought it was up to me to try to help.

These words contain in outline the challenge which M.I.T. held for Compton. To the School of Engineering and the School of Architecture, he added the School of Science and the Graduate School, and in asking Vannevar Bush to become Dean of Engineering he ensured a strong infusion of applied science into the engineering programs. The new emphasis upon graduate study created the orientation needed to make M.I.T. not only a source of trained people for industry but a force in creating new industries, new technologically based systems, and, ultimately, new social realities.

In Compton's inaugural address he formulated the purpose of the Institute as "the development of science and its useful applications." And time and time again he stressed the necessity of greater emphasis upon the fundamental sciences both in their own right and as the bases of the various branches of engineering. To undertake the necessary research, Compton stated the need for an endowed research fund of $5 million, the income of which would support faculty research. He could not conceive of a more appropriate or urgent program for the Institute than to continue its work of developing both principles and people for applying science to the problems of human welfare. It was this vision that enabled M.I.T. to become a leading force in the development of the natural sciences and the related technologies.

The emergence of M.I.T.'s leaders as science advisors at the national level started during that period: in the early 1930s President Roosevelt formed a Science Advisory Board, with Compton as chairman, with the task of recommending a more effective general governmental policy with respect to scientific work. During the Second World War, Karl Compton, Vannevar Bush, and many other members of the Institute were to play extraordinarily important roles in Washington as members of the National Defense Research Committee, the Office of Scientific Research and Development, and other war-related agencies; and M.I.T. undertook to build a "national" laboratory — the Radiation Laboratory — where 4,000 staff members were concerned with the development of radar in the broadest sense of the word, from the basic physics of magnetrons and electromagnetic theory to the testing of various radars on the battlefront.

With its size, its scope, and its style, the Laboratory created a new way of doing scientific and technical research for the public welfare. It also changed M.I.T. in the sense that interdisciplinary and interdepartmental cooperative efforts oriented toward the solution of major national and societal problems became a hallmark of the Institute. Under the leadership of Julius Stratton, Albert Hill, John Slater, and others, the Radiation Laboratory was transformed into the Research Laboratory of Electronics, oriented toward certain areas of physics and the problems of communication in synthetic and living systems.

Soon after the end of World War II, there came a book that presented a new synthesis and changed the way in which many came to view the second "industrial revolution." The book, written by M.I.T.'s famous mathematician, Norbert Weiner, was called *Cybernetics,* after the Greek word meaning "steersman" in the sense of governor. Subtitled "Communication and Control in the Animal and in the Machine," the book tried to bring together statistical communication theory, servomechanisms and feedback, and advanced views on the potential of computers. *Cybernetics* became something akin to an intellectual endowment for the early years of the Research Laboratory of Electronics, and from this stimulus grew most of M.I.T.'s contemporary work in human communication, including the neurosciences, psychology, and linguistics, as well as much of the computation activities.

The world after the Second World War saw a blossoming of new technologies. Building especially on new knowledge in solid-state physics, electronics began to pervade our lives: from television to copying machines, from transistorized hearing aids to magnetic computer memories, from air defense and air navigation to tape recorders. Electronics became the lead technology and Boston's Route 128 exhibited the many uses, practical and analytical, to which electronics and information processing could be put.

But electronics was not the only technology to intervene forcefully into our lives. The post-World War II period saw also the first flowering of the biomedical technology of drugs and vaccines. Thanks to sulfonamides, the penicillins, (it was the M.I.T. chemist John Sheehan who achieved the first synthesis of penicillin), the streptomycins, and so forth, the infectious disease patterns and the death rates of the industrialized world were irreversibly changed.

At M.I.T. toward the mid-century, the issues that science, technological development, and especially the bomb, had started to pose were reflected in the Report of the Lewis Commission, which had been established to review the state of education at the Institute. Central to that report was the view that we should be able not only to create new science and to innovate technology, but also to relate them to human values and aspirations; that we should have a certain responsibility for forecasting the impact of scientific and technical developments on society; and that we should learn how to manage the new technologies in a humane fashion.

These concerns were expressed at M.I.T. in the foundation in the early 1950s of the School of Humanities and Social Science (originally called Humanities and Social Studies) and the Sloan School of Management (originally called the School of Industrial Management).

In reviewing this half century, therefore, we can see enormous changes in the Institute and in the fields represented here. In the natural sciences, for example, the physical sciences clearly occupied most of the "map" in the 1930s. It was not until the post-World War period, when the tools of physics, chemistry, and modern engineering became increasingly used to study the structures and phenomena of life that the biological sciences started to occupy an ever increasing fraction of the map. This quest to understand the physical chemistry of living structures was expressed as early as 1944 by Schrödinger's little book entitled *What is Life.* By 1953, numerous experiments on the hereditary substance DNA and Pauling's discovery of the helical structure of protein led Watson and Crick to formulate their model of DNA: a double helix which thus provided a mechanism for the copying of genetic material. There followed numerous discoveries relating to the genetic code, to the functional regulation of genes, to immunology, as well as many others which contributed to our understanding of complex biological functions at the molecular level.

But far from standing still during that same period, the physical sciences moved on many fronts. In the wake of the pre-World War II cyclotron, nuclear accelerators became more and more powerful and the traditional "ultimate" building blocks of the atom were smashed into more and more fragments. The catalogue of nuclear particles now has more than 100 entries, many with rather colorful names. It is only, literally, in the past few weeks that Murray Gell-Mann's quark model and the theory of quantum chromodynamics have found strong support in an experiment conducted in Hamburg under the leadership of Samuel C.C. Ting, holder of M.I.T.'s Thomas Dudley Cabot Institute Chair. The Ting team, composed of 57 scientists and engineers from seven countries (including the People's Republic of China), was able to detect through inference a **gluon,** whose existence is crucial to our understanding of the fundamental binding forces in nature. The excitement created by this discovery in the year of the Einstein centennial is attributable, at least in part, to the possibility that it may permit us to progress towards a more unified theory of the forces of nature that have been identified to date.

Almost the same excitement is perceived in astrophysics, where the 1930s appear now to be the distant Middle Ages of the field. Satellites, data processing, computers, radio and X-ray astronomy have transformed the disciplines. With these new technologies astrophysicists are delving further into ancient questions as well as mysteries previously unimagined: pulsars, quasars, black holes, the origin of the universe, the evolution of stars, life on Mars and in the cosmos. At M.I.T., the key data processing devices for the radio telescope were developed at the Research Laboratory of Electronics and our astrophysicists have played a leading role in many key experiments, such as the quite recent discovery of the double quasar.

Again, comparable progress has been made in the earth sciences where chemistry, oceanography, and the signal processing approach to the study of seismic waves, together with the unifying model of plate tectonics, have brought about new understandings, ranging from the nature of earthquakes to the exploration and utilization of the earth's resources.

The past 50 years have been a time of extraordinary accomplishment in mathematics as well. Benefiting, as have the other sciences, from an enriching stream of refugee scholars and researchers from central Europe in the 1930s and 1940s, American mathematics took a leap forward, and our nation has become, as medals and prizes now testify, the foremost center of world mathematical research. The great currents and discoveries of mathematics in the past several decades — among them the deeper understanding of the higher dimensional spaces in which much of science and technology builds its models, a new overview of algebraic and combinatorial aspects of mathematics and its applications, significant progress on such difficult and complex areas of analysis as partial differential equations, and discovery of deep and unexpected connections among various previously distant fields of pure and applied mathematics — all of these have been enriched in major ways by work done at M.I.T.

There is not enough space to document — be it ever so briefly — progress in the other natural sciences, in economics, in linguistics, in the neurosciences, and in the many

fields of engineering that build on progress in basic science. All that we have attempted is to sketch how Karl Compton's vision has shaped the Institute and served human welfare.

There has been no attempt to document here the equally important complementary influences of technological progress upon other branches of human knowledge and action. New technologies enhance the potential of the natural sciences and medicine, they shape the theoretical concepts of the social sciences and the practices of management. Not only do new instruments, tools and software enable us to make previously "impossible" measurements, but most profoundly they raise new scientific, human, and societal problems. Progress in technology often forces us to admit that we don't really understand what we thought we did and thereby leads us to inquire much more deeply into new areas of basic science. By its ability to affect crucial human events such as birth and death, contemporary technology confronts humanity with questions of value and choice that transcend and challenge our established mores.

Today M.I.T. is a university *sui generis.* It is unique because there is no other institution of higher education so deeply involved with research. It is unique because of its international character, which does justice to the fact that the natural sciences are invariant under different skies. And it is unique in its concern not only with the sciences and engineering but with their human and societal consequences.

When one talks about research at M.I.T. one needs to realize that about half of this community of roughly 18,000 people are students. And practically all of the graduate students, more than half of the undergraduates, and all of the more than 500 postdoctoral fellows are involved in research. So are the nearly 1,000 members of the faculty, and so too, of course, are the members of the research staff. Today, the sponsored research budget represents roughly half of M.I.T.'s campus expenditures. In other words, M.I.T.'s activities — in education and in public service — have research as the most explicit motivating force.

The people who make up M.I.T. are obviously attracted to the Institute as a research university of a special kind. Over the years, these people have changed. They now come from all states and from all over the globe. Their backgrounds, interests, and ages are now more diverse. Increasingly, they are women as well as men. And while we have not yet met our goals for equal opportunity for minorities and women among our faculty, students, and staff, M.I.T. today is, in these terms, a much different place from M.I.T. in 1930.

This multi-faceted, multi-cultural community has developed a lifestyle which is probably unequalled in tempo and intensity of atmosphere. People live and work at the Institute almost 24 hours a day and 12 months a year. And they do not confine their activities to research and teaching on the campus. They are bridge builders: between the university and industry or government — seeking, in the tradition set by M.I.T.'s founder, to put knowledge to work for social purpose.

THE DEVELOPMENT OF ACADEMIC PROGRAMS

One pleasant surprise of the Leadership Campaign was that it stimulated extensive conceptualization and development of emerging academic programs — those new activities that departments, faculty members, and laboratory groups were just beginning, and whose success depended upon the availability of support and, often, new facilities. The preparation of the goals for the Campaign required an extensive dialogue between the central administration and the many academic groups of the Institute. The development of specific proposals for programs and facilities continued that dialogue and brought the projects and programs into sharp focus. In the process, we have found that the need for seeking outside support has accelerated the conceptualization of many nascent programs.

In the casebook for the Campaign, we discussed the many faces of communications, information, and computation at M.I.T. and the central and growing role of these processes in the society at large. Today, the concepts of computation and information pervade almost every activity at M.I.T. to some degree, sometimes unknowingly, sometimes as a central purpose.

Two programs that came into focus as part of the Leadership Campaign during the past year present exciting illustrations of this influence. They are: the bringing together of activities in the Department of Psychology, the Department of Nutrition and Food Science, the Department of Linguistics and Philosophy, and elsewhere in the Institute to form centers for the study of cognitive science and the brain sciences; and the plan to bring together M.I.T.'s many teaching, research activities, and public exhibition programs in the areas of the visual arts and of media technology. Activities in the arts and related media are burgeoning at M.I.T. Each year more than 1,000 students enroll in visual arts courses and the Institute's galleries attract thousands of visitors. Media research includes such developments as computer-based video and graphic information systems, computer-controlled electronic music, and innovative work in film, video photography, graphics, and various other forms of image processing. A diverse faculty group has been designing the initial stages of a new environment for the Visual Arts and Media Technology, in which the first phase would contain primarily areas for exhibitions and archival storage together with a media gallery, a "listening gallery," and work space for resident artists.

Several other academic programs have emerged during the year to the point where they require support from our fund-raising effort. Among these are: 1) the development of a major program in the field of microstructures and large-scale integrated circuits; 2) an enhanced teaching and research program in the field of polymers; 3) a new center for study and research in materials processing; and 4) a broad-based program relating to chemicals, human health, and the environment.

Funds are needed as well to help meet the needs for additional and improved space for programs in the Alfred P. Sloan School of Management. Since its establishment in 1950, the Sloan School has grown both in size and stature. Its alumni occupy numerous positions of leadership both in the United States and abroad. Its student applications, enrollment, faculty research activities, and instructional programs (including those for mid-career and senior executives) have increased so dramatically that the School's facilities can no longer meet its varied needs. The School plays an increasingly key role in M.I.T.'s interdisciplinary efforts involving complex technological and societal problems, such as energy, health, and management of the environment. There is thus an urgent need to improve both the quantity and the quality of the School's space including the construction of new classrooms and the renovation of offices and seminar rooms, and to increase the size of the School's faculty.

Cognitive Science and the Brain Sciences: Two Centers in Formation

Earlier in this report we noted that under the influence of Norbert Wiener, the Research Laboratory of Electronics interpreted its mission in communication quite broadly, so as to include both the nervous system and linguistics. Since then, research and teaching related to these two areas have grown substantially at the Institute, as new experimental tools in the neurosciences and new models of language become available.

Understanding brain function, perception, and cognition is clearly central to M.I.T.'s Department of Psychology, but these interests have spread throughout the Institute. For example, faculty members in the Department of Nutrition and Food Science offer a graduate program in neural and endocrine regulation and do frontier research ranging from neurotransmitters to the influence of nutrition on behavior; members of the Department of Linguistics and Philosophy are deeply involved in studying the relation of language and mind. Furthermore, interest in the brain and/or cognition extends to most departments in the School of Engineering, to the Departments of Chemistry and Biology, and to such interdisciplinary units as the Division for Study and Research in Education, the Research Laboratory of Electronics, the Laboratory for Computer Science, the Artificial Intelligence Laboratory, the Harvard–M.I.T. Division of Health Sciences and Technology, and the Whitaker College.

In the last two years, scientists from several of the above mentioned academic units have held, under the sponsorship of the Sloan Foundation, a series of critical discussions and workshops from which emerged a certain consensus regarding the nature and the objectives of cognitive science. The participants from M.I.T. (and several other academic institutions and industrial laboratories) were able to formulate certain common approaches to the study of mental representation and computation. Initially they are attempting to construct theories capable of accounting for the knowledge

Advances in the earth sciences have been accomplished with the aid of the signal processing approach to the study of seismic waves. Here, two graduate students in Earth and Planetary Sciences use a seismograph in their research of New England earthquakes.

that underlies one's ability to use one's native language, to represent objects in three-dimensional space, or to engage in logical thinking, temporal planning, or memory. This is obviously an ambitious undertaking, but so strong was the desire of these colleagues from several M.I.T. departments to cooperate in a center that would provide a focus for individual and collaborative research that during the spring a Center for Cognitive Science was formed with partial support from the Sloan Foundation. This Center is not only undertaking theoretical research but is also taking responsibility for outlining educational programs for predoctoral students and postdoctoral fellows. With regard to facilities for such a center, there is little need to build or combine intricate laboratory facilities, although the Institute has tried to provide a modest amount of additional contiguous space for the program.

In the brain sciences, there has been a comparable explosion of interest and excitement in gaining a better understanding of how the brain functions — from the role of minute quantities of highly specific chemicals to the behavior of humans. Faculty from throughout the Institute have expressed an interest in collaborating in this field, in both teaching and research programs, and their activities and enthusiasm have encouraged us to attempt to draw the relevant programs together in a Center for the Brain Sciences. We are seeking support for the space and sophisticated laboratory facilities needed to provide a suitable working environment in this field. In the meantime, we asked a group of faculty members from several departments to examine opportunities and the need for a coherent educational program. Out of their efforts have come not only a heightened awareness but also a better utilization of existing courses and facilities as well as better academic counseling for our students.

Recognizing that it will take time to obtain funds for an entire building for such a center, which would house the

Psychology Department as well as faculty and staff from other departments or laboratories who would participate in the center's programs, we plan to add a floor to the building being constructed for the Whitaker College. In the meanwhile, we are actively seeking support for the Center's long-range program.

It seems highly appropriate that an institution dedicated to the progress of science and technology should also be in the forefront of trying to understand the functioning of the human brain, this prime generator of knowledge and learning.

Engineering and Industrial Innovation

A number of new programs in the School of Engineering reflect the Institute's continuing concern with the problems of industry and industrial society.

The Department of Electrical Engineering and Computer Science, for example, is developing, in collaboration with several interdepartmental laboratories and faculty from other departments, a major new educational and research thrust in the fabrication, design, and architecture of very large-scale integrated electronic circuits. The program reflects the needs of industry for people with theoretical and design capabilities that are far beyond the current state of the art.

During the past 20 years we have seen an astonishing development in the complexity of integrated electronics circuits capable of performing sophisticated logic functions. In the early development of integrated circuits, the problem was not so much the selection of logic functions or the design of the circuits as it was the problem of resolving materials defects associated with their fabrication. During the past decade, the primary question became one of which functions to incorporate in integrated circuits, that is, which functions would be general enough to allow for large-scale production. (This was the period which saw the development of microprocessors capable of incorporating in one or a few integrated circuits all the elements of a programmable general purpose computer.) Today, except for circuits with repetitive structures (such as memories), industrial ability to manufacture integrated circuits outstrips the ability to design them. We are now faced with the need for the enormous difficulty of designing circuits containing several hundreds of thousands of components.

The program under development includes study of the traditional problem of improving fabrication techniques and reducing the size of components so that larger, more dense, circuits can be made with fewer defects. However, it goes beyond these issues to consider design aids that are necessary if complex geometrical designs embodying random logic are to be fabricated, and to consider questions of computer architecture. The two-dimensional physical structure of integrated circuits allows parallelism in structure and organization which we now do not know how to use effectively, but which could lead to fundamental changes in the organization of computers and computation.

Another area in which education and research will have an influence on industrial development is the field of polymeric materials. For more than three decades, members of the M.I.T. faculty have made important contributions to our understanding of the properties and uses of polymers, and have trained successful contributors to the field. Nevertheless, in spite of the size, quality, and diversity of these efforts, the Institute is not recognized as a world leader in this field. We believe that this lack of recognition is a reflection of the lack of internal organization in polymers research and education, as well as insufficient interaction with industry where much of the creative work in polymers is done.

The School of Engineering, in collaboration with the Center for Materials Science and Engineering, is developing a new interdepartmental research and graduate educational program which will involve faculty from Chemistry, Chemical Engineering, Materials Science and Engineering, and Mechanical Engineering.

The new program will help establish an internal sense of community, greater external visibility, and a means by which continued evolution and improvement can occur. The program will provide a forum for educational activities in polymers at the graduate level, for strengthened interaction with the industrial community in the area of polymers, and for several new research initiatives.

The School of Engineering is establishing as well a Materials Processing Center, which will be concerned with process fundamentals and applications, materials systems engineering, and the societal issues which arise in the processing of raw and semifinished materials and in the impact of new materials processing technologies.

Advances in the usefulness and reliability of materials depend on a combination of modern scientific understanding and the art of the traditional artisan. An important concept is that performance of materials can be controlled through control of internal structure, from the macroscopic to the atomic level. Without this concept, the performance and reliability we have come to expect from modern aircraft and computers, for example, could never be achieved. A second important concept underlying the center is that economic and low energy processing of materials in a competitive world depends on assimilation of new technologies such as robotization and adaptation of processes to utilize these technologies.

The new center will provide a way for staff and faculty to contribute effectively to broad materials processing problems and to interact with industry and government in finding solutions to these problems. Research activities in the center will include work on lighter-weight materials for energy-efficient automobiles, primary-materials production processes which have lower economic and social costs, computer-aided and adaptive materials processing, and processing by supercooling and ultra-rapid solidification.

Chemicals, Human Health, and the Environment

During recent years the public has become increasingly aware of the problems of the control of chemical hazards. The resolution of these issues is often left to adversary proceedings in which industry, governmental agencies, and public interest groups are often far apart in their approaches. M.I.T. and Harvard have faculty members of outstanding competence in toxicology, epidemiology, and other disciplines necessary to a thorough understanding of these complex issues. Thus it is not surprising that both industry and government have encouraged the two institutions to undertake a major joint program that would contribute to the development of the requisite scientific and technical knowledge and to the education of the large number of toxicologists, epidemiologists, and so forth, who are needed.

During the last year the faculty members and academic administrators from Harvard and M.I.T. met repeatedly to explore how a joint program on the impact of chemicals on human health and the environment could come into being. We at M.I.T. have been helped by the experience with our Center for the Study of Health Effects of Combustion. This center combines the efforts of the Harvard–M.I.T. Division of Health Sciences and Technology and of the Energy Laboratory in exploring the health effects of present and potential fossil fuels. Key objectives include the assessment of potentially mutagenic and/or carcinogenic species from combustion of fossil fuels and the identification of possible alternative combustion methods and fuel utilization strategies that could reduce or eliminate health hazards. The utilization of fossil fuel resources in an environmentally and economically acceptable manner depends upon our acquiring critical knowledge that relates to both technology and public health.

In our exploratory discussions with our Harvard colleagues we have focused on four basic areas: health sciences, environmental sciences and engineering, analytical methods and instrumentation, and policy analysis and regulation. Such a program would range from basic biology, chemistry, and chemical technology to economics, public policy, management, and law. It would need to be able to identify and diagnose problems, working in conjunction with both industry and regulatory agencies. There is the hope that it might help in creating a climate for the rational discussion of a variety of viewpoints on these issues and that such discussions might result in materials for information and education of the public.

This summer we ran a small educational pilot operation: about 50 young professionals took a 10-week program dealing with toxicology, analytical chemical methodology, epidemiology, occupational health, the regulatory framework, and environmental decision making. The program was taught by M.I.T. faculty members, augmented by Harvard colleagues and lecturers from industry and government.

The forthcoming year is one in which we intend to develop rather specific plans for cooperation between our two institutions, to clarify an appropriate organizational structure, and to explore funding possibilities from a variety of sources at a level that will make such an ambitious program possible.

Computational Environment and Challenges

Many of the previous programs illustrate pioneering areas of research related to information and communications. As noted above, the uses of information processing throughout the Institute's educational, research, and administrative programs have become so pervasive that we decided to take a critical look at the adequacy of M.I.T.'s computational resources and its needs for the future.

During the year, the Committee on Future Computational Needs and Resources, which was appointed in the spring of 1978 by the Chancellor and the Provost, reported on its conclusions and recommendations. The committee concluded that we do not make full use of computers in education and research, that our present path is not leading in the right direction, and that, except in specific situations, the Institute's overall use of information processing cannot be characterized as pioneering. In sum, the committee felt that, although the Institute is preeminent in research in the computer sciences and in the applications of information processing, we are, with respect to our *use* of information processing, particularly in instruction, not unlike the shoemaker's children.

In contrast to the present state, the vision of the near future proposed by the committee includes widespread use of interconnected personal computers or terminals for use by students and faculty, for such diverse purposes as assisting in research, new modes of teaching and learning, preparing or solving homework problems, maintaining schedules, report writing and editing, and communicating with fellow students or instructors.

As a first step in moving toward this computational environment, the committee recommended the establishment of an "M.I.T. Network" for tying together various information resources, and the creation of regional computing centers within the Institute. Further, they recommended that a number of experiments be conducted in education, office automation, graphics, personal computers, computerized classrooms, mixed media, and library uses of computers, as well as far-reaching reorganization of Institute resources relating to information processing and communication. The Committee recommended as well that responsibility for all information processing and communication technology at M.I.T. be centralized under a single senior individual, and that a standing faculty committee be created to maintain oversight in these areas.

There has been extensive discussion of this report during the year, and of the educational and institutional climate which it portends. While decisions have yet to be made concerning implementation of the recommendations, the general directions outlined in the report have been accepted in principle and several departments within the School of Engineer-

ing are moving toward the establishment of significant decentralized computing resources — an indication that the committee's view of the future is founded in already perceived needs.

UNDERGRADUATE RESEARCH: OPPORTUNITIES AND ACHIEVEMENTS

This year marked the tenth anniversary of the founding of the Undergraduate Research Opportunities Program. This unique program — known as UROP to all — has had a significant effect on the educational climate of the Institute as it is perceived by both students and faculty, and is, we believe, the most important single development in education at M.I.T. in the past several decades. It provides the opportunity for undergraduates to join with faculty members in an inquiry of mutual fascination.

Through UROP the Institute has sought, as early as possible in the undergraduate experience, to: 1) teach students by example the process of seeking answers and assimilating knowledge; 2) foster meaningful student-faculty relationships on several levels, with inquiry into a topic of intellectual interest providing a framework for advising, tutoring, and related needs of the students; and 3) develop student maturity and self-confidence in both personal and professional dimensions.

Perhaps UROP's most valuable contribution is that it provides ways for our undergraduate students to achieve a sense of individual accomplishment and to generate for themselves the excitement of intellectual discovery.

At M.I.T., undergraduates have the opportunity to inhabit a very special moral and intellectual universe, a world that is both demanding and rigorous, but also sympathetic. It is the responsibility of our faculty to guide these young people, to encourage their earnestness and drive, but especially to firmly require that they fulfill the promise that got them into M.I.T. in the first place. Simply offering such students a modern campus and a plentiful menu of good courses does not distinguish the foremost universities of the world from one another. But in the providing of a research-based undergraduate educational experience, M.I.T. offers a special challenge and opportunity to students who want to take an active role in their own education.

The program had its intellectual genesis in a lecture delivered at the Institute in 1957 by Dr. Edwin H. Land, president and founder of the Polaroid Corporation. The lecture, entitled "The Generation of Greatness," had a profound impact on M.I.T. Dr. Land said of undergraduates:

> One feels, when among our young students, that they are honest and honorable and full of ideals; that they come to the door of our universities with the dream of being our colleagues; that if we could provide them intimate leadership there would be no discipline to which they would not subject themselves and no task so arduous in the pursuit of knowledge and science that they would not devote themselves to it.

Dr. Land elaborated his view that if students were provided with "intellectual ushers" — senior colleagues who would guide them through the university and start them on personal research projects — they would gain first-hand, and early-on, a sense of intellectual excitement and individual accomplishment.

The Undergraduate Research Opportunities Program began in September 1969 with nearly 300 participants (more than twice our estimate of initial interest), and grew to 600 in the second semester. It began without fanfare, without a bureaucratic master plan, without staff or clerical support, and without formal administrative housing in any particular office. It also began at a time of unprecedented ferment and deep discontent at M.I.T. and on campuses throughout the nation. In the midst of this, M.I.T. invited its undergraduates to come into campus research pursuits as full, contributory citizens. It was a bold move against a swift current of development that had followed the massive World War II research efforts — a development which converted several leading universities into world class research institutions at the price of orienting faculties toward graduate and postdoctoral education with such intensity that undergraduates were effectively disenfranchised from the mainstream of intellectual action.

Ten years and several thousand undergraduate researchers later, UROP has come of age at M.I.T. For the past several years about 2,500 students each year have been engaged in undergraduate research. The program now spans all 23 academic departments, including those which do not award undergraduate degrees. And while UROP is the principal vehicle for undergraduate research, this kind of activity is also available through senior thesis, project laboratories, special topics in engineering, special problems in physics, political science internships, or the cooperative programs in several engineering departments, to name a few. The total atmosphere is what counts. The genesis of this atmosphere lies in the origins and tradition of M.I.T.; UROP's contributions have been primarily the provision of scale, interdisciplinary links, articulation, and overview.

The scope and complexity of UROP has consistently enlarged and deepened: from the original program of research for credit during the academic year, UROP has grown to include summer research (which usually carries stipend support), and ties with off-campus professional organizations (including a special emphasis in the medical and health-related fields). Students can begin or end a research effort whenever they wish at any point during the year, without being bound by the formal academic calendar; the "average" UROP student spends 8 to 15 hours per week (over a period of one and one-half years) on his or her research project. And by engaging research staff as well as faculty in this type of educational encounter, the UROP experience heightens the sense of shared purpose which is a special feature of M.I.T.

The success of the program is demonstrated by the increasing sophistication of students' work and the routine expectation of many faculty that high-quality research contributions will come from undergraduates. A significant number of entering freshmen state that the opportunity to

participate in research is the determining factor in their decision to enter the Institute. For a student to undertake a UROP project today means to become engaged with the full range and complexity of the research experience: defining a problem, writing proposals, securing funding, communicating with colleagues, dealing with recalcitrant equipment, interpreting results, making formal presentations, and reaping rewards (such as they may be).

Read what some of the students have said about their experience:

Again I must acclaim UROP for the opportunity it has given me to see how the field of experimental physics really is; the experience has been a great help to me in choosing possible career goals, in addition to being one of the finest methods for learning a subject I've ever come across. UROP is still the one major reason that M.I.T. is worth suffering through over and above any other undergraduate institution.

Aside from the obvious increase in practical lab experience which I gained through my summer UROP work, there were two more important lessons. The first was learning when to quit. That is, when should a project be abandoned as simply not being possible or profitable. In a standard lab course this problem is never faced. Even when things don't work, there is the knowledge that somebody else in the lab got the product and you better get it too. The second important lesson was in learning to work with people in the development and carrying out of a research project.

Frankly, my only regrets are that I didn't do UROP sooner. When you are responsible to an individual or group for the knowledge in an area, you apply yourself to it more thoroughly. Sometimes it is easy to just get by with a B in a course if you aren't called upon to recite on the subject. But when you're a UROP-er, you kind of set your standards higher. In other words, I didn't dare not know some things once I undertook the project. I've had to really learn (and am still learning) because of this project. Without UROP, I may have just let it slip by.

Faculty take supervision of undergraduate research seriously. Just as students come to M.I.T. to learn from and with M.I.T.'s faculty, so too do first-rate professionals join M.I.T.'s faculty to work with these fresh, spirited colleagues.

There is a personal return to the faculty member in such collaboration. Beyond the pride in seeing one's protege develop, there is professional pride in conveying the knowledge, culture, and traditions of a field. In the UROP partnership there is relaxing of the tension between the demands, sometimes distracting, of conventional teaching formats and the unrelenting pressures of research management.

There is also tangible professional benefit to the faculty member, not unlike the returns of working with other research colleagues, but perhaps with greater humor and less formality. The influence of a particular collaboration on a faculty member outlasts the individual undergraduate and affects the professional life of the faculty member, perhaps by letting him or her start a new field or approach, perhaps by accomplishing the feasibility study that finally elicits major moral and financial support, perhaps by questioning a long-held tenet or theory, perhaps by adding a measure of humanity to a lonely pursuit.

Thus, faculty development is a major aspect of UROP's overall contribution to M.I.T., especially in the junior faculty ranks, where assistant professors scramble to get research programs supported and under way, to attract research students, and to establish themselves professionally. These enterprises are greatly aided by the presence of undergraduate research colleagues, who in exchange, want greater access to precisely these faculty members because of their verve, rapport, up-to-date knowledge, and youth. As these faculty enter the senior ranks, they know no norm other than that of undergraduates as bona fide research partners. An increasing number of these faculty are passing through the tenure threshold, permanently building undergraduate research into M.I.T.'s future. This is as we believe it should be.

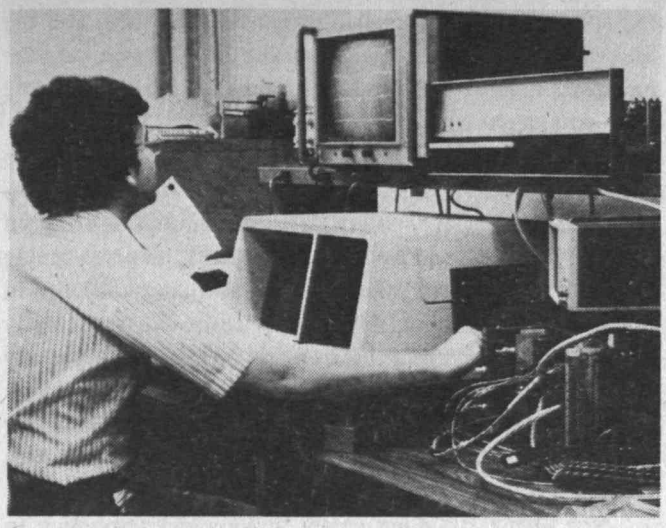
THE LEARNING ENVIRONMENT BEYOND THE CLASSROOM

In our annual report last year we mentioned our intention to review the organization of student support services at the Institute, with particular focus on the Office of the Dean for Student Affairs and the various services it provides.

This review led to changes aimed principally at improving services for graduate students; strengthening institutional support to undergraduate students and particularly to the departmental and the general freshman advising programs; and rationalizing the services for women students, international students, and the student residence programs, both on and off campus. As of the writing of this report the reorganization of the Dean's Office suggested by the study has been completed and a national search is under way for the new Dean. A broader review of the organization of various student-related responsibilities which are found in offices and departments throughout the Institute has yet to be completed.

In addition to clarifying the service and management issues of organization, the review of student services has raised again some important questions of educational and institutional policy, and we wish to reflect on these questions here.

First is the question of how to meet the Institute's responsibility to support and to complement the academic program. Besides the formal offerings in the classroom and the laboratory, American universities have traditionally provided advising and other support activities — including a variety of residential, social, and cultural programs on campus — which are not a part of the formal curriculum, but which add significantly to the education and to the opportunities for personal growth and development of students. At M.I.T. these support activities have been provided by faculty members and administrative staff members both within the departmental framework and Institute-wide. A growing concern in recent years, highlighted by the review, is how to meet students' wish for more support and advice from faculty members outside of the formal classroom setting. It is understandable that faculty may have limited involvement in educational support activities, given the



The Institute's pervasive use of information processing in research programs is illustrated by a microprocessor system developed at M.I.T's Biomedical Engineering Center for Clinical Instrumentation. The system is being used to edit tapes for a library or annotated electrocardiograms.

many other demands on their time in this period, the restricted departmental budgets, and the pressure on younger faculty to compete for research support and for professional recognition. The continued personal interest and involvement of our faculty members in the professional and the personal growth of students, however, is a cardinal ingredient in an M.I.T. education. We have heard this time and time again from alumni and students; and the success of the UROP experience is a testimony to the value of such one-to-one interactions. The dramatic increase of student and faculty participation in UROP during the past decade is a positive sign in this respect. But growing student criticism and concern over the quality and availability of advising suggest that we need to pay more attention to the supportive roles that M.I.T. faculty play outside, as well as within, the context of their own research. We are particularly struck by the growing interest among undergraduates to receive more, better, and earlier help in making their career choices. They see a need for career counseling, reaching down to their early academic decisions about a major, and they see a need for more help in exploring possible shifts or combinations of departmental majors in their upperclass years. Quite often they feel uncomfortable in discussing these topics with their departmental advisors who appear to them to be knowledgeable about and committed to a specific profession or field.

It is not very clear to what extent this malaise about advising is occasioned by changing expectations of students or even by the changing and complex configurations in the fields of knowledge, rather than by a lack of faculty involvement. All of these factors are probably influential to some extent. But whatever the cause, there is an important need for the faculty, collectively and individually, to respond to these student needs. And there is a need for the administration to plan the institutional responses, so as to encourage and facilitate faculty involvement, rather than substitute for it with professional counseling.

Several universities have chosen to provide professional academic counseling outside their departmental structure. But we believe that would tend to change the character and dilute the quality of our education. A major section within the Dean's Office, devoted to Undergraduate Academic Support, was created this summer to operate as an academic information center for students and for their advisors and for departments in order to strengthen (rather than substitute) the student-faculty bonds, and encourage the integration of career counseling and academic advising to the extent possible. The Committee on Educational Policy is studying how to improve advising, and we have had several discussions about this problem with department heads. We hope that the heightened awareness about the needs as perceived by the students will bring about a needed improvement, and we plan to reassess the situation next year.

A second concern highlighted by the review has to do with a need to make more support services available to our students who do not have major problems of adjustment, but whose education and experience at M.I.T. would be enhanced if they had more opportunities for engagement in academic, intellectual, cultural, or social activities. Many of these opportunities can be provided in the context of the campus residential environment. In principle there is a great variety and choice in the residential program for undergraduate students both in the dormitory system on campus and off campus in fraternities and independent living groups. A combination of circumstances, however, including the lack of resources for adequate development of both facilities and programs under the Housemaster-Graduate Resident system, have led to the conclusion that our residential system is not developed to its full potential, and that we should take better advantage of the living environment as a focus for programs which can support and complement our academic offerings. We are taking some steps this year, including the addition of a full-time business advisor for fraternities and independent living groups, a modest increase in program support to Housemasters and Tutors, and a major study and review of all dining programs and facilities on campus.

Perhaps the most significant gain on the residential front was our decision in June to proceed with the building of a new dormitory for 300 undergraduates, made possible by an anonymous gift of $2 million. Serious crowding during the past five years had exacerbated the housing problems and, although the cost of the new house will require significant debt financing (if no additional gift capital is found), we felt that going forward with the building at this time will alleviate the serious crowding and will limit the rapid escalation of the cost of this necessary facility.

Unfortunately we cannot report progress on the problem of housing for graduate students. Campus facilities cannot begin to meet the demand here, and the housing in the Greater Boston area becomes scarcer and more expensive each year.

We are very happy, on the other hand, to report that we are moving ahead with the construction of a much expanded

athletic facility, whose funding from generous gifts of alumni and friends is almost complete.

In the past 30 years universities have gone through major transformations as far as their relations to students are concerned. Following World War II universities were viewed as intensive suppliers of trained professionals for industry and government; in the 1950s and early 1960s they were expected to fill a parental role for a fast growing college population; in the late 1960s they became the battleground for youth independence and for social and political activism; and in the 1970s they have been characterized by privatism and a utilitarian emphasis.

We cannot make a prediction about student attitudes in the 1980s any more than we could have predicted today's state 10 years ago. But we can say that our students seem to be making more out of what is available to them at the Institute today than they did during the previous decade. And we can also speak of the value of a periodic stock taking, such as we did last year, with ample time to listen and to reflect before taking institutional steps which should provide the best possible climate for the growth of our students.

RESEARCH AND RELATIONS WITH THE GOVERNMENT

In our report last year we noted the growing impact of governmental action on the Institute and suggested that it was necessary for the research universities to strive to improve communications with both the Executive Branch and the Congress. We were particularly apprehensive about the apparent deterioration of the spirit of collaborative partnership between the universities and the Federal government. Forged in World War II and reinforced in the years following Sputnik, that partnership encouraged and sustained university research and, in turn, brought the nation to world preeminence in science and technology and contributed to the welfare and prosperity of society.

Underlying that partnership was a consensus regarding the inherent importance and contribution of basic research. In recent years, however, in absence of proof that such work will produce immediate practical results, basic research had come to be measured primarily in terms of fiscal accountability. In the last few years this had become a pervasive theme.

This year we can report a considerable improvement in the university-government relationship — an improvement based on continuing efforts to achieve mutual understanding of complex and diverse problems and to rectify misunderstandings of the nature and role of university-based research in the nation.

At the beginning of the year, the emphasis on fiscal accountability by the Federal government and the apprehensions of the universities were focused on proposed revisions of the cost principles governing Federal reimbursement of research costs at colleges and universities. The university community feared that the proposed revisions represented an abandonment of the partnership concept and a point of transition to a different relationship between them and the Federal government — a relationship in which universities would be regarded as vendors essentially indistinguishable from commercial organizations.

M.I.T. joined the debate and took strong exception to those proposed revisions which would have seriously impaired the financial viability of the Institute's specialized research facilities, and would treat students, however deeply involved in research, solely as course-taking students in calculations of reimbursable indirect costs. We particularly stressed the concept that research and instruction, especially at the graduate level, are interactive, mutually supportive activities which cannot be separated one from the other except in the most artificial and mechanical ways, and with great cost to both.

The Office of Management and Budget responded to the expressions of alarm by providing an opportunity for further comment and discussion and by giving serious consideration to the views of both Federal and university representatives. When finally issued last spring, the revised principles required some significant changes in university procedures, but had been sufficiently modified from the earlier proposals that M.I.T. can accommodate itself to them without sacrificing its ability to conduct research effectively.

The mood and attitude of Congress toward the universities had also been reflected in the 1978-79 National Science Foundation appropriations bill, which included a limitation on the level of faculty salaries which could be charged to NSF grants. The implications of this in terms of Federal involvement in the internal compensation and other policies of universities were enormous and disturbing. Our discussions of these concerns with Congressional sponsors of the requirement and their staffs appear to have been successful, for the limitation did not recur in the NSF appropriations bill for the 1979-80 year.

These and other examples of interaction with the Congress and Federal agencies have provided both encouragement and hope. They suggest that problems with the relationship are in large part the result of misunderstanding, inadvertence, and inattention of the kind that can result in any relationship taken too much for granted. While the Congress and the executive agencies have perceptions of the universities with which we might take issue, they are held without malice, and those who hold them are both accessible and willing to change their views if the arguments are well articulated on the basis of fact rather than rhetoric. Where the perceptions are not in our favor, but nonetheless accurate, the universities must listen more closely to criticism.

Encouraged by the fair hearing we received in connection with the revised cost principles, we have since communicated to OMB our concern that technological innovation in the country has been impaired by the increasing difficulty which major research universities are finding in their efforts to preserve their dynamism and freedom of inquiry. One

reason for this difficulty is the fact that there are few discretionary funds, independent of specific research grants and contracts, which universities can use to maintain the vitality of their research efforts by seeding the exploration of new ideas, supporting talented young investigators, acquiring equipment not otherwise available for critical on-going experiments, and smoothing out the discontinuities inherent in project-by-project annual funding. We have suggested that regular provision of funds for the support of independent research, which is already available to non-university contractors, would provide a partial remedy. We also have urged that modifications be made in the cost principles relating to interest cost in order to permit universities to acquire the capital funding necessary to acquire new research facilities and equipment.

If we are to build effectively on the dialogue which has already been initiated, however, we must go beyond the discussion of cost principles and engage in a meaningful exchange as to the role and purposes of the research universities and the nature of the relationship which they and the Federal government should preserve.

In most major US universities, research is so deeply woven into the fabric of the general university that it no longer stands clearly outlined; the fact that it is an essential part of the national basic research effort is therefore obscured. In contrast, most other nations separate their scientific and technical research from their teaching efforts. They support governmentally financed research institutes separate from their teaching institutions to the serious detriment of both. We must explain this difference and the dynamics of our research universities more effectively if we expect the Federal government to truly understand our special problems and needs.

During the past year a more meaningful dialogue was conducted between the universities and the Federal government than at any prior time in this decade. Both have developed a far deeper understanding of the attitudes and problems of the other.

We look forward now with the hope that this dialogue will provide the foundation upon which we can build once more a relationship which strengthens the universities as institutions and thereby their capacity to help the nation sustain its position of scientific and technological preeminence.

IN SPECIAL RECOGNITION

The individual efforts and distinctions on the part of our faculty have been many during this past year. Two members of the faculty were elected to the National Academy of Engineering, bringing to 50 the total number of M.I.T. faculty in the Academy. The new members this year, both members of the Department of Electrical Engineering and Computer Science, are Professor Peter Elias and Professor Robert G. Gallager. In April, the National Academy of Sciences elected three M.I.T. faculty members, and another who will join our faculty in September 1979, to its ranks, thus bringing the total number of M.I.T. officers and faculty members in the Academy to 76. The new members are Professor Keiiti Aki and Professor Gordon H. Pettengill, both of the Department of Earth and Planetary Sciences, and Dr. Norman C. Rasmussen, head of the Department of Nuclear Engineering. Also elected was Dr. Thomas S. Kuhn of Princeton University who will join our faculty this fall as a professor in the Department of Linguistics and Philosophy and in the Program in Science, Technology, and Society.

In May, three members of the M.I.T. faculty were elected fellows of the American Academy of Arts and Sciences. They are: Professor Daniel G. Quillen of the Department of Mathematics; Professor Carl Wunsch, head of the Department of Earth and Planetary Sciences; and Professor Gene M. Brown, head of the Department of Biology.

Within the Institute, special honor was given this year to Professor David J. Rose of the Department of Nuclear Engineering, who was selected as the recipient of the 1979-80 James R. Killian, Jr., Faculty Achievement Award. The Award is given each year to a member of the faculty in recognition of extraordinary professional accomplishment and service to the Institute. Known for his work in fusion technology, nuclear waste disposal, and his concern for the ethical problems arising from advances in science and technology, Professor Rose was cited by the Faculty selection committee as having had three distinguished careers: "that of scientist and engineer, that of the technology/policy analyst, and that of the bridge builder between the scientific and theological communities."

This past year saw several new appointments to senior posts in the academic administration. They include Dr. Herbert S. Bridge, director of the Center for Space Research; Dr. Ronald C. Davidson, director of the Plasma Fusion Center; Dr. Kent F. Hansen, associate dean of the School of Engineering; Dr. James L. Elliot, director of the George R. Wallace Astrophysical Observatory; Dr. John F. Elliott, director of the Mining and Minerals Resources Research Institute established at M.I.T. by the Department of the Interior; Dr. Daniel J. Kleitman, head of the Department of Mathematics (effective July 1, 1979); Dr. Francis E. Low, director of the Laboratory for Nuclear Science; and Dr. Gerald N. Wogan, head of the Department of Nutrition and Food Science.

Several new appointments to senior administrative positions also should receive special mention. Professor James D. Bruce was appointed director of the Industrial Liaison Program, to succeed Professor Samuel A. Goldblith, who was appointed in September as Vice President for Resource Development at the Institute. In November, Dr. James A. Hester was selected Executive Vice President of the M.I.T. Alumni Association, succeeding Mr. James A. Champy, who left the Institute to enter private business.

The past year also marked the retirement of seven distinguished members of the faculty. Their years of service to the Institute and to their students will long be remembered and appreciated. They are James M. Austin, professor of

meteorology and director since 1969 of the Summer Session; Murray Eden, professor of electrical engineering on leave at the National Institutes of Health; John W. Irvine, Jr., professor of chemistry; Robert I. Rathbone, professor of technical communication; Claude E. Shannon, Donner Professor of Science and professor of electrical engineering and mathematics; Theodore Wood, Jr., professor of literature and American studies; and Henry J. Zimmermann, professor of electrical engineering and former director of the Research Laboratory of Electronics.

We were saddened this year by the deaths of several colleagues whose presence we miss, yet whose contributions to the stature and character of M.I.T. are long-lived and gratefully remembered.

Professor Frederick J. Adams, an internationally known city planner and first head of the Department of City and Regional Planning (as it was called in 1944), died in March 1979, at the age of 77. He guided the department in its development as a foremost center in the field and was a valued member of the M.I.T. faculty for 38 years.

Dr. Henry A. Hill, an M.I.T. alumnus and distinguished member of the Corporation, died suddenly in March 1979, at the age of 63. An organic chemist himself, Dr. Hill strongly encouraged the expansion of educational opportunities for members of minority groups in science and engineering at the Institute, and was especially interested in fostering closer working relationships between science and industry.

Professor Daniel B. Ray of the Department of Mathematics died in February 1979, following a heart attack. A member of the M.I.T. faculty since 1957, Professor Ray was an international authority on many aspects of mathematical analysis and for many years took an active and valued role in the administration of the department.

Dr. Louis S. Scaturro, an assistant professor of nuclear engineering, died in May 1979, following a heart attack. At the age of 28 he was considered a pioneer in the study of power loss from plasmas, and his untimely death cut short a life of promise.

Dr. Donald S. Tucker, professor of economics at M.I.T. from 1919 until his retirement in 1955, died in February 1979, at the age of 94. His enthusiasm for teaching was legendary and his spirit of good cheer infected his colleagues and classrooms alike.

Mr. George R. Wallace, Jr., donor of M.I.T.'s Wallace Astrophysical Observatory and the Wallace Geophysical Observatory, died in September 1978, at the age of 88. An M.I.T. alumnus and noted philanthropist, his generosity and vision contributed greatly to the development of the earth and planetary sciences at the Institute.

STATISTICS FOR THE YEAR

The following paragraphs report briefly on the various aspects of the Institute's activities and operations during 1978-79.

REGISTRATION

In 1978-79 student enrollment was 8,881, an increase of 169 over the 8,712 in 1977-78. This total was comprised of 4,594 undergraduates and 4,287 graduate students. Graduate students who entered M.I.T. last year held degrees from 388 colleges and universities, 239 American and 149 foreign. The foreign student population was 1,633, representing 18 percent of the total population. The foreign students were citizens of 93 countries.

Degrees awarded by the Institute in 1978-79 included 1,187 bachelor's degrees, 972 master's degrees, 65 engineer's degrees, 381 doctoral degrees — a total of 2,605.

The number of women at M.I.T., both graduate and undergraduate, has increased continually. In 1978-79, there were 1,466 women students at the Institute, compared with 1,382 in 1977-78. In September 1978, 231 first-year women entered M.I.T., representing 22 percent of the entering class.

Minority* students at M.I.T. have increased in numbers as well. In 1978-79 there were 685 minority students (graduate and undergraduate) at the Institute, compared with 635 in 1977-78. The first-year class entering in September 1978 contained 162 minority students, representing 15 percent of the class.

STUDENT FINANCIAL AID

During the 1978-79 year the student financial program was again characterized by increases in the overall need for financial aid.

A total of 2,235 undergraduates who demonstrated the need for assistance (49 percent of the enrollment) received $6,788,761 in scholarship aid and $2,139,511 in loans. The total, $8,928,272, represents a slight decrease in aid compared with last year. (There was a significant decrease in the amount of M.I.T. loans awarded, and a corresponding increase in loans obtained from commercial sources.)

Scholarship assistance was provided by the scholarship endowment in the amount of $2,262,313, by outside gifts for scholarships in the amount of $1,028,564, and by direct grants to needy students totaling $1,651,967 (an increase of 23 percent). Scholarship assistance from M.I.T.'s own operating funds was provided to the extent of $1,385,000 (a 16 percent increase). The special program of scholarship aid to minority group students represented an additional $136,925 from specially designated funds. An additional 242 students received direct grants from outside agencies, irrespective of need. The undergraduate scholarship endowment was aided by the addition of new funds which represented an increase of about $500,000 and which raised the principal of the endowment to $26,173,000.

Loans totaling $2,139,511 were made to needy undergraduates. Of this amount, $365,351 came from the Tech-

*Minority students include Blacks (non-Hispanic), Native Americans (including Alaskan Natives), Hispanics, and Asian or Pacific Islanders.

nology Loan Fund, and $1,774,160 from the National Direct Student Loan Program. An additional $1,929,203 (a 60 percent increase) was obtained by undergraduates from state-administered Guaranteed Loan Programs and other outside sources.

Graduate students obtained $538,434 from the Technology Loan Fund and $429,286 from the National Direct Student Loan Program. The total, $967,720, represents a 31 percent reduction compared with last year's level, reflecting the wider availability of state-guaranteed student loans. Of this total, $209,794 was loaned under the Guaranteed Loan Program and qualified for Federal interest subsidies and guarantees. The total loaned by M.I.T. to both graduate and undergraduate students ($3,107,231) was a decrease of 26 percent from last year's total.

CAREER PLANNING AND PLACEMENT

A quickening demand for the Institute's graduates in engineering and the physical sciences rose to a crescendo in 1978-79, with 416 separate organizations coming to the Career Planning and Placement Office to interview prospective employees. The office was the scene of 8,527 recruiting interviews. In only three years since World War II has the interview count exceeded 8,000. The demand was also strong for graduates of the Sloan School.

Confirming the evidence of interview schedules, starting salaries in many fields went up sharply, exceeding the 7 percent of Washington's wage and price regulations if not the rate of inflation. In electrical engineering, where demand was particularly strong, bachelor's salaries rose 13 percent (beating the rising cost of living by three percentage points). In management, master's salaries jumped 13 to 20 percent. The **median** salary accepted by masters was $20,400, and the median accepted by doctors was $25,520. The Sloan School reported an **average** starting salary for its master's graduates of $28,700 (up from $23,800 in 1977-78).

In other fields the employment picture was mixed. In architecture, for example, the demand for graduates showed signs of strengthening after several lean years, perhaps reflecting new approaches in the profession to the servicing of clients' needs. Graduate students and postdoctorals in the life sciences came to the office in increased numbers to discuss the alternatives to academic employment.

The high demand for engineering graduates showed itself in the area of Alumni Career Services. Demand was particularly strong for electrical, mechanical, and chemical engineers, as well as for graduates in computer science. Many employers felt the need to come to the office in person to announce their requirements. The increase in employer activity was matched by a drop in the number of alumni requesting placement assistance. Favorable as the market was for job seekers, however, 40 percent of registrants still took six months or more to find satisfactory employment. Compared with 1977-78, this year's registrants were generally older, held higher degrees, and were at higher salary levels. Fifty-seven percent were over 40 and 41 percent earned over $30,000. Fewer registrants were in manufacturing, and more were in service organizations (consulting, government, teaching, and so forth). A number were engaged in significant career changes, among them faculty members leaving academia and officers retiring from the military.

FINANCES

As reported by the Vice President for Financial Operations and the Treasurer, the total financial operations of the Institute, including sponsored research, increased from the level of 1977-78. Education and general expenses — excluding the direct expenses of departmental and interdepartmental research, and the Lincoln Laboratory — amounted to $144,069,000 during 1978-79, compared to $130,928,000 in 1977-78. Reflected in the finances of the Institute was the use in operations of unrestricted funds of $5,565,000, compared with $5,875,000 the preceding year.

The direct expenses of campus departmental and interdepartmental sponsored research increased from $89,736,000 to $107,521,000, and the direct expenses of the Lincoln Laboratory's sponsored research increased to $102,279,000 from $96,595,000 because of an overall increase in government research support.

The construction program of the Institute continued to make progress in 1978-79 with the book value of educational plant facilities increasing from $205,992,000 to $208,195,000.

At the end of the fiscal year, the Institute's investments, excluding retirement funds, students' notes receivable, and amounts due from educational plant, had a book value of $387,463,000 and a market value of $467,349,000. This compares to book and market values of $348,481,000 and $409,603,000 last year.

GIFTS

Gifts, grants, and bequests to M.I.T. from private donors increased from $31,287,000 in fiscal year 1977-78 to $33,944,000 in fiscal year 1978-79. The latter figure includes unrestricted direct gifts to the Alumni Fund of $2,021,000 which constituted part of the total of $5,158,000 reported by the Alumni Fund in 1978-79.

PHYSICAL PLANT AND CAMPUS ENVIRONMENT

Construction of a facility to house a 10 megawatt, superconducting, cryogenic generator adjacent to the High Voltage Laboratory was completed during the year. The generator, driven by a gas turbine engine, will eventually have its output fed into the Cambridge Electric Company system for a 30-day period to test the feasibility of this innovative approach to electric generation.

Other construction projects completed during the year

included a 13,000 gross square foot (gsf) Interim Animal Care Facility on Vassar Street; renovations to the Suffolk Building, E38; and construction of three lecture halls for the Sloan School of Management in Building E51.

The following projects are in design: a 122,000 gsf building for the Whitaker College of Health Sciences, Technology, and Management; a 95,000 gsf Medical Services Building; a 111,000 gsf Athletic Facility; an 8,000 gsf Animal Care Facility within Building E18; and a complete renovation program for the Webster Building, E40.

Various facilities studies were conducted during the year and a number of space change renovations and renewal projects were completed. Included among the latter were facilities for the Laboratory for Nuclear Science, Department of Biology, Department of Chemistry, Department of Meteorology, Research Laboratory of Electronics, Department of Architecture, Center for Materials Research in Archaeology and Ethnology, and the Center for Materials Science and Engineering.

In the fall of 1978, after careful study of admissions information, campus housing retention rates, and proposed alternatives to relieve some of the resultant dormitory crowding problems, the decision was made to proceed with the design of a new undergraduate housing facility for 300 students. A "Program Planning Group" consisting of students, faculty, and staff was formed. This group met during the winter and produced a report which is now being used to generate a facilities program. It is planned that construction of the dormitory will begin in March of 1980 with occupancy scheduled for September 1981.

The major maintenance program to update the quality of residential facilities continues with several projects completed or under way. A major project this year is the conversion of the Westgate heating system from an independent boiler to the central steam system. It is expected to be completed before next year's heating season begins and will provide a more efficient and economical system. Major renovations to the graduate residents' facilities in Baker House are also under way. The sprinkler protection system, planned in conjunction with the Safety Office, is proceeding in McCormick Hall public areas and the apartment kitchens in Eastgate.

At the initiative of the Vice President for Operations and the Dean for Student Affairs, the Chancellor appointed a Committee on Campus Dining. The committee was charged to review the existing dining programs and to submit comprehensive recommendations which will enhance the quality of the living, learning, and working environment on campus. It is anticipated that these recommendations will be made early next year.

Jerome B. Wiesner, President

Paul E. Gray, Chancellor

October 5, 1979

Conservative estimates of the total national cost of cancer for 1979 are in the region of $30 billion.

myriad of synthetic chemicals in commerce, less than 1,000 have been shown to be carcinogenic in animals, and these mostly belong to special sub-classes — such as chlorinated olefins, alkyl halides, and aromatic amines — widely used by industry.

There is substantial evidence incriminating industrial chemicals as major causes of cancer. Consider, for example, "Estimates of the Fraction of Cancer in the United States Related to Occupational Factors," a draft report issued by the U.S. Department of Health, Education and Welfare (H.E.W.) in September, 1978. (The final report is in the process of being submitted to the *Journal of the National Cancer Institute*.) Prepared by ten leading experts from the National Cancer Institute, the National Institute of Environmental Health Sciences, the National Institute for Occupational Safety and Health (N.I.O.S.H.), and the International Agency for Research on Cancer, the report conservatively estimates (with documented exposure and epidemiological evidence) that up to 38 per cent of total cancer mortality over the next three decades will be associated with asbestos and five other "high-exposure" carcinogens (arsenic, benzene, chromium, nickel oxides, and petroleum fractions).

The report is in striking contrast to industry "guesstimates" that occupational exposures cause less than 5 per cent of all cancers. Not only are such industry allegations undocumented in relation to exposure data — which industry still insists are confidential — but they also reflect simplistic assumptions that single causes (including questionable carcinogenic factors such as high-fat diets) are responsible for most cancers. The causes of cancer are generally multiple, with more than one factor contributing to risk (as illustrated, for example, by synergistic interactions between smoking and asbestos exposure in the induction of lung cancer among workers).

The findings of the H.E.W. report, alarming as they are, still represent a serious *underestimate* of the impact of occupational carcinogens: they exclude the effects of radiation and about twelve other epidemiologically confirmed occupational carcinogens; the effects of occupational carcinogens on the general community, due to their discharge or escape from industrial plants into the outside air, water, and land, are not considered; the effects of more recently introduced industrial chemicals have not been gauged through current cancer rates; the majority of epidemiological studies so far undertaken in the workplace, and on which the estimates are based, have been in larger industries which are likely to be less hazardous than the more numerous small plants (manufacturing, handling, or processing carcinogenic chemicals under even more poorly controlled conditions); and the duration of follow-up in most epidemiological studies on carcinogenic exposures in industry has been for periods less than the necessary lifetime observation period, and are therefore likely to minimize the degree of risk. These exclusions from the H.E.W. estimates are likely to outweigh possible overestimates of exposure due to alleged industry-wide improvements in work practices.

The Costs of Cancer

Total direct costs of treatment for an individual cancer patient were estimated by H.E.W. in 1971 to range from $5,000 to $30,000. Indirect costs, such as loss of earnings from premature disability, are often much greater. Total national costs from cancer, both direct and indirect, were estimated by H.E.W. in 1971 to be about $15 billion annually, and estimates for 1979 are in the region of $30 billion.

In addition to these *recognized* costs of cancer, there are a variety of other costs — often referred to as "externalized" costs — that have generally been ignored or denigrated. Consider workers' compensation. Payments to workers who have contracted occupationally related cancer result not only in externalization of industry's costs but also seriously mask the full extent of the national costs of the disease. And the efficiency and equitability of these procedures leave much to be desired. For instance, state compensation systems have abjectly failed to deal with occupational health problems, particularly for diseases with long latency periods (such as cancer). Impossibly heavy burdens are placed on workers, or their heirs, to unequivocally demonstrate causal relationships between their cancers and prior occupational exposure to carcinogenic agents. Furthermore, state compensation systems make no provisions for identification and medical examination of former workers (retired or active elsewhere) who were previously exposed to carcinogens but who are not yet clinically ill.

Workers' compensation laws, which vary from state to state only in their degree of inequity, are based on an implied trade-off in which workers surrender their rights to sue their employer in exchange for the guarantee of adequate compensation in a

nonadversarial process. The courts have almost consistently upheld the legality of the denial of right to sue, but have generally failed to maintain the right to an uncontested adequate compensation.

Results of recent surveys by the Department of Labor highlight the problem:

☐ The average length of time from onset of disability to the first disability payment is one year for a disease claim (compared to two months for an injury case).

☐ Sixty per cent of disease cases that are eventually compensated are contested (compared to ten per cent of injury awards).

☐ The probability of litigation approaches ninety per cent for serious diseases such as cancer.

☐ Fifty-five per cent of disease claims are settled by compromise and release agreements (compared with sixteen per cent of injury cases).

☐ The total average compensation payment for permanent occupational disease is less than $10,000 (compared with $23,400 for similar injury cases).

☐ Compensation for death caused by occupational disease averages about $3,500 (compared to $57,500 for an injury case).

☐ Foreign countries settle proportionately more disease claims than does the United States. (In the case of Sweden, the disparity is about twelve-fold.) The claims-determination process in most other countries is in the hands of a disinterested party, in contrast to the U.S. procedure.

An important recent development in attempts to reform the inequities of current compensation systems, which would help to internalize some of the costs of occupational cancer, has been the introduction of S.3060 by the Senate Human Resources Subcommittee on Labor. This bill is designed to provide comprehensive reform of compensation programs, and to mandate uniform national guidelines, while allowing a reasonable degree of autonomy at the state level. Regrettably, S.3060 has not been reported out of committee, and its chances for passage are slim (even though earlier versions of this bill were introduced beginning in 1972).

Consider also occupational surveillance costs. N.I.O.S.H. has recently estimated that for the relatively small number of regulated carcinogens alone, the associated cost of worker surveillance is in the region of $8.5 billion.

Another category of externalized costs derive from medical malpractice suits against company doctors who fail to inform workers of medical findings that might otherwise have motivated them to limit further exposure. For example, there are ten lawsuits (totaling over $50 million) against Kent Wise, former physician for a Johns-Manville plant in Pittsburgh, Calif., on the grounds that he deliberately withheld information from workers on X-ray evidence of asbestos-induced lung disease. In the future, such professional malpractice lawsuits — for failure to protect workers and to inform them of occupational hazards — will almost certainly be filed against company-employed engineers, chemists, industrial hygienists, and executives.

The "spillover effect," and potential community cancer suits, represent a major but as yet unexplored additional set of externalized costs. Toxic and carcinogenic chemicals from inside a petrochemical plant, for example, are discharged or escape to the outside community, so that the occupational disease hazards are "shared" with local residents. It is also awesome to note that an entire calculus of other externalized costs — the dimensions of which have been barely considered — reflects the consideration that many carcinogenic chemicals possess other toxic effects, notably teratogenic (causing birth defects) and mutagenic.

Industry's Responses: A Poor Track Record

"Industry," a heterogeneous array of interests and objectives, has generally presented a common front of intransigence in response to proposed regulation of toxic and carcinogenic chemicals. Accumulation of information on chemical hazards in the workplace has not been paralleled by development of technological means to control them. Indeed, industry insists that attempts at regulation are stifling technological innovation.

In support of the status quo, industry appears to have evolved a complex set of strategies. Their essence is to downplay risks due to a particular product or process, to overstate the social benefits and uniqueness of the product or process, and to exaggerate the costs and difficulty of regulation. These strategies are sometimes presented frankly as industry positions, but they usually come from industry front organizations and quasi-professional associations (such as the Nutrition Foundation, the American Council on Science and Health, and the Council on Agricultural Science and Technology), or from well-selected academic consultants who usually give no hint of their often close and pre-existing relationship with the client industry. The elements of these strategies, with some examples, include:

Heavily industralized states, such as New Jersey, experience "excess" overall and organ-specific cancer rates. (Data displayed here are for white females, age-adjusted, and expressed as annual mortality rate per 100,000 population for the 1950-1969 period.) (*Source: Mason and McKay*)

Cancer death rates	State			Excess rate for New Jersey (per cent)	
	New Jersey	Wyoming	North Carolina	Wyoming	North Carolina
Overall	147.9	109.1	107.0	36	38
Lung	7.2	4.4	4.5	64	60
Bladder	2.9	1.6	2.1	81	38
Leukemia	5.7	4.8	5.6	19	20
Colon and rectum	21.7	12.4	10.9	71	99
Pancreas	6.3	5.1	5.2	24	21
Breast	30.6	21.1	19.3	45	59

Minimizing risks. The Quebec Asbestos Mining Association maintains that asbestos-caused disease is a reflection of past working conditions that have improved so much that the industry is now safe. A frequent position of trade associations and industry front organizations in general is that there is no risk in exposure to "relatively low" levels of carcinogenic chemicals.

Blaming the victim. The American Industrial Health Council, an offshoot of the Manufacturing Chemists' Association (M.C.A.), ascribes cancer among workers to smoking, poor diet, alcohol, sunlight, and individual hypersusceptibility rather than to exposure to carcinogens in the workplace.

Diversionary tactics. Industries insist on degrees of scientific precision and legal definition that cannot possibly be met in toxicological or epidemiological studies, often coupling this with rejection of carcinogenicity test data in animals and demands for long-term human studies over the next few decades. Naturally, regulatory action should be deferred until the results of such studies are in.

Influencing policy. Powerful, well-focused, and well-financed industry lobbyists, and the national Chamber of Commerce network, represent a national force that has often been galvanized to subvert the enactment of protective legislation and the promulgation and implementation of standards.

Exhausting the agencies. Once an agency has decided to regulate, or has been obliged to regulate in response to pressure from labor or public interest groups, industry generally resorts to legal action, insisting on a protracted case-by-case reexamination of fundamental principles of toxicology and carcinogenesis, while at the same time claiming trade secrecy on related questions of exposure and alternative noncarcinogenic products and processes.

Central to the complex of industry strategies has been *control of the data* — their generation, interpretation, and availability — which form the basis for regulation. Such data extend beyond health and safety to product efficacy and to manufacturing, marketing, and compliance costs as well. Detailed analyses of the track record of industry, with reference to a wide range of case studies in the workplace, consumer products, and the general environment, provide ample documentation for the overall thesis that information provided by industry, or by individuals and institutions with direct or indirect industry connections, should be suspect until proven otherwise. Data are commonly destroyed, manipulated, or suppressed.

Examples of suppression include:

☐ The policy of the Chemical Manufacturers' Association (formerly the M.C.A.) to deny workers the right to know what chemicals they are exposed to in trade-name products;

☐ The assertions of the asbestos industry that the hazards of asbestos products were largely unknown before the 1960s, when as recently revealed (particularly by the 1978 "Asbestos Pentagon Papers"), such information was known to industry executives and scientists in the 1930s;

☐ The early failure of the Dow Chemical Company to reveal to the Occupational Safety and Health Administration (O.S.H.A.) and the Environmental Protection Agency (E.P.A.) results of tests showing chromosome damage in workers who were exposed

to levels of benzene under 10 ppm. Simultaneously, the company was fighting against regulations designed to limit such exposures and was insisting on their harmlessness;

☐ The action of the Pharmaceutical Manufacturers Association and American College of Obstetricians and Gynecologists in filing suit against the Food and Drug Administration's September, 1976, decision to label estrogens with warnings of the risk of uterine cancer.

Examples of manipulation include the alteration of records and reporting of nonexistent slides by Hazleton Laboratories in the course of toxiocological tests on the sweetener Aspartame and the drug Aldactone; and the economic analysis, commissioned by the Society of the Plastics Industry, on the impact of meeting a less-than-one ppm vinyl chloride standard in the workplace, which predicted massive costs that subsequent experience proved to be exaggerated by many orders of magnitude.

Examples of destruction include both the *routine* — Dow and Du Pont admitted in 1973 that workers' records were destroyed after ten years, even while both companies had claimed in-house epidemiological evidence of the long-term safety of three occupational carcinogens (ethyleneimine, 1-naphthylamine, and MOCA) that O.S.H.A. was attempting to regulate; and the *dramatic* — immediately prior to a federal investigation in April, 1977, Industrial Biotest Laboratories destroyed its records on thousands of industrial chemicals, drugs, food additives, and pesticides (many of which had been developed under contract to the Chemical Industry Institute of Toxicology, a proclaimed source of reliable data for the major chemical companies).

But industry is now evolving a new set of strategies — as before, to counter and limit the regulation of toxic and carcinogenic chemicals — which represent a radical departure from previous policies. Industry is now shifting emphasis from denial of risks to an admission that these risks do exist but must be accepted as part of a trade-off for alleged societal economic benefits. This shift in emphasis derives from the depressed economic climate and other considerations, including: a continuing series of damaging disclosures on the extreme unreliability and self-serving nature of much industry safety data; the evolution of independent scientists whose concerns about public health have encouraged successful challenges of a wide range of industry's contentions in toxicology and epidemiology; and some outstanding new administrative appointments to

Annual per cent changes in cancer incidence rates, 1970–1975

Cancer site	White male	Black male	White female	Black female
Lung	1.0	0.7	8.5	11.6
Bladder	2.4	8.2	3.2	10.0
Rectum	0.3	4.5	2.3	9.9
Colon	0.8	4.9	1.0	4.9
Melanoma (skin)	6.0	36.6‡		
Cervix			−6.5	− 6.1
Uterus			9.0	12.0
Breast			2.3	8.9
All sites	0.9	2.3	2.2	6.1

Since 1933, and especially over the last decade, there have been progressive increases in cancer incidence rates for all ages throughout the U.S. (*Source: N.C.I., Third National Cancer Survey, 1969-1971; and S.E.E.R. Program*)

Cancer is now the only major fatal disease whose incidence is on the rise.

federal regulatory and research agencies. Faced with these conditions, industry is now shifting its prime focus from the scientific debate in regulatory agencies to the economic debate in Congress, the courts, and the Council on Wage and Price Stability.

Ever sensitive to changing national moods, industry's demands for deregulation have recently become more clamorous and linked to Proposition 13-style tax reform, inflation, alleged free-spending by runaway regulatory agencies, and the growing big-government intrusion into free enterprise. Full-page advertisements in leading national newspapers complain that "the spiraling costs of regulation" (both for administration and compliance) are inflationary and innovation-stifling. The industry position is buttressed by articles and letters in leading journals and newspapers from prominent academic spokesmen and industry front organizations, and by restrictions on health and environmental regulations originating from the White House itself. Apart from the self-serving nature of industry demands for deregulation, these reflect the myopia of traditional economists preoccupied with the G.N.P. and the immediate costs of compliance rather than with the heavier and largely externalized delayed costs of failure to regulate.

Industry demands for deregulation in pollution and preventive health areas are in interesting contrast with its insistence on continued economic regulation to protect monopolistic practices. In spite of all the praise lavished by industry and its public relations machinery on the concept of free competition in a deregulated market, industry fights vigorously to foster economically protective regulation ("corporate socialism") whenever its interests are threatened.

To Regulate or Not to Regulate

In March, 1978, President Carter issued an executive order on regulatory reform which included the requirement that regulatory agencies develop economic impact analyses (i.e., to estimate the effects on business) of all major proposed standards. The order was warmly received by the business community and was promptly endorsed by the U.S. Chamber of Commerce, among others. Since then, the administration has imposed increasing restrictions on health and environmental regulations, particularly through its agent, the Regulatory Analysis Review Group of the Council on Wage and Price Stability (C.O.W.P.S.).

C.O.W.P.S. issued a report in October, 1978, for example, sharply critical of O.S.H.A.'s "generic" cancer policy (which would require automatic but flexible rule-making procedures for all proven carcinogens instead of developing rules on a tedious and protracted chemical-by-chemical basis). C.O.W.P.S. cited the economic impact analysis prepared for the American Industrial Health Council by Booz, Allen, & Hamilton — admitted by C.O.W.P.S. to be "seriously flawed" — as its authority for stating that the total costs of the proposed regulation would be inflationary. The C.O.W.P.S. report was roughly coincident with President Carter's announcement of his new anti-inflation program, asserting that inflation is the nation's number one problem and that prompt remedial action, including across-the-board austerity measures, must be undertaken. C.O.W.P.S. was also critical of the O.S.H.A. benefits analysis which, not surprising in a generic approach, failed to address the cost-benefit question on a carcinogen-by-carcinogen basis. This criticism was buttressed by reference to the October, 1978 decision of the Fifth Circuit Court which overturned O.S.H.A.'s proposed benzene standard largely on grounds of economic infeasibility and cost-benefit considerations. The case is now pending before the Supreme Court.

Cost-benefit analyses (upon which the administration's approach heavily depends) do not adequately reflect the delayed costs of deregulation, or of failure to regulate, in terms of disease, death, and environmental degradation. Some uncertainties inherent in quantitative risk assessment from animal test data are illustrated by the 10-million-fold range in current estimates of the carcinogenic hazards of saccharin (*see table, p. 51*). Quantitative risk assessment is a premature science fostered by pressures to express public health hazards in economically simplistic terms. And complicating, difficult-to-measure factors, such as synergisms and multiple exposures, only magnify the uncertainties. The recognized annual costs of cancer (in the region of $30 billion) reflect medical bills and income loss — minimal but hardly adequate value estimates for pain, suffering, and loss of life — quite apart from a wide range of externalized costs.

Furthermore, cost-benefit analyses raise important questions of equity. Those few who profit from the manufacture or processing of the carcinogen and who resist bearing the immediate costs of compliance (despite the fact that many of these costs are generally "redistributed" through tax write-offs and

Federal research efforts emphasize cure instead of prevention. And for an environmentally induced disease such as cancer, this is irrational.

price pass-throughs) are not the many who suffer the long-delayed but serious consequences of failure to regulate. It would seem reasonable to require that the interests of a worker exposed to hazardous conditions and of a consumer exposed to hazardous consumer products (both generally involuntarily and unknowingly) should receive substantially more protection than is now afforded by the regulatory process.

The costs of regulation are incorrectly evaluated, often failing to incorporate the economic advantages of regulation-stimulated innovations such as alternate technologies and product or process substitutions. (A good example was the substitution of toluene for benzene in the early 1960s, an action that virtually eliminated occupational leukemia in the photogravure and shoe-making industries in northern Italy.) Compliance may also encourage substantial economies by recovering and recycling valuable chemicals, otherwise lost as air and water pollutants, and may create whole new pollution-control industries that provide goods and services and, of course, jobs.

An important consideration for "economic impact" is that in most cases the regulated industry — not the regulatory agency — has a virtual monopoly on data needed to assess costs of compliance. And it is no great surprise that industry estimates of the costs of regulation are often highly exaggerated.

The clear need for detailed independent scrutiny of industrial compliance estimates and economic impact assesments (and of analyses by C.O.W.P.S. based on industry claims) is afforded by the vinyl chloride (VC) example. The plastics industry strongly objected to the 1974 O.S.H.A. proposal for a less-than-one ppm occupational standard for VC on the grounds that it was beyond their compliance capability and too expensive besides. To bolster these claims, the Society of the Plastics Industry hired Arthur D. Little, Inc., and O.S.H.A. hired Foster D. Snell, Inc., to estimate the economic impacts of the new standard. The consulting firms predicted costs as high as $90 billion and the loss of up to 2.2 million jobs. These estimates were grossly exaggerated and also failed to reflect the high costs of VC-induced cancer and other diseases in workers as well as excess miscarriages in women living in proximity to VC plants. In spite of massive industry lobbying and pressures, O.S.H.A. stood firm on the new 1 ppm standard, which it put into effect on April 1, 1975.

The above estimates, in light of subsequent experience in the plastics industry, proved to be incorrect by several orders of magnitude. Within one year, the new standard was met without any major economic dislocation. B.F. Goodrich, one of the industry giants, redesigned its manufacturing technology to enclose VC manufacturing and handling processes and to plug possible sources of leaks. Additionally, a "stripping" process was developed to reduce levels of the unreacted VC monomer in the polyvinyl chloride (PVC) resin and to decrease VC loss in the process (thus reducing both worker exposure and contamination of the surrounding community). The initial capital costs of compliance were about $34 million. Contrary to the estimates of the consulting firms, B.F. Goodrich found that the new clean-up technology actually cut labor costs and could be profitably leased. (In spite of this, B.F. Goodrich increased the price of its PVC products in 1976, claiming higher production costs and blaming them on regulatory standards.) The experience of Union Carbide was similar. Late in 1975, a company official acknowledged how unexpectedly easy it had been to comply with the 1 ppm standard. Currently, the VC/PVC industry is enjoying an unprecedented boom.

Compliance costs are generally estimated on the implicit and self-serving assumption that a particular product has societal efficacy and utility, even in the absence of supporting evidence or in the presence of contrary evidence. Such assumptions cannot be substantiated for a wide range of carcinogenic products. Saccharin's efficacy in the treatment of diabetes and obesity, for example, has never been documented in the scientific literature, and its main use, ironically, is by healthy adolescents. Aldrin and Dieldrin have produced widespread environmental and human contamination, but their manufacturer (Shell Chemical Co.) was unable to produce evidence of efficacy in the 1973 E.P.A. cancellation hearings. The major target insect population, it turns out, is resistant to these pesticides.

The costs of carcinogenicity tests are often cited by industry as a heavy and unjustified compliance expense, particularly on the grounds that too many new chemicals are being introduced into commerce each year to be handled by conventional animal testing and that the cost of such testing would be prohibitive. In fact, the number of these new chemicals is under 700 annually. There is every reason to believe that current facilities could be expanded to cope with this number of chemicals, and without excessive strain. There are large potential facilities at

Estimated Human Risks from Saccharin Ingestion of 0.12 grams per day		
Method of high-to-low-dose extrapolation	Lifetime cases/ million exposed	Cases per 50 million/yr.
Rat dose adjusted to human dose by surface area rule		
Single-hit model (Hoel, 1977)	1,200	840
Multi-stage model (with quadratic term) (Hoel, 1977)	5	3.5
Multi-hit model (Scientific Committee of the Food Safety Council, 1978)	0.001	0.0007
Mantel-Bryan probit model (Brown, 1978)	450	315
Rat dose adjusted to human dose by mg/kg/day* equivalence		
Single-hit model (Saccharin and Its Salts, 1977)	210	147
Multi-hit model (Scientific Committee of the Food Safety Council, 1978)	0.001	0.0007
Mantel-Bryan probit model (Brown, 1978)	21	14.7
Rat dose adjusted to human dose by mg/kg/lifetime* equivalence		
Single-hit model (Brown, 1977)	5,200	3,640
Multi-hit model (Scientific Committee on the Food Safety Council, 1978)	0.001	0.0007
Mantel-Bryan probit model (Brown, 1978)	4,200	2,940

*Milligrams per kilogram of body weight

Estimating risk is by no means an objective, universally agreed-upon procedure, as the divergence of these data — derived by a variety of methods — can attest. (*Source: Committee for a Study on Saccharin and Food Safety Policy (National Academy of Sciences)*)

The absence of a national public health constituency at a grass-roots level is probably the single most important impediment to cancer prevention.

the national laboratories, such as at Oak Ridge, Tenn. and Argonne, Ill., in addition to a large facility at the National Center for Toxicological Research in Arkansas. In addition, the bioassay program (under the new leadership of the National Toxicological Program) is planning to subtantially increase its testing program to handle larger numbers of chemicals.

With regard to expense, the annual cost of testing one chemical for carcinogenicity (in groups of 50 mice and rats, of each sex, at two dose levels) is about $200,000. Properly conducted carcinogenicity tests also provide information on a wide range of other chronic toxic effects, including testicular damage (leading to sterility), central nervous system damage (leading to paralysis or behavioral changes), and damage to the liver (leading to cirrhosis). The $140-million cost for testing 700 chemicals would be unlikely to result in substantial increases in production and retail product costs. Such testing costs are about 0.2 per cent of the 1976 $72-billion gross sales of the chemical industry. The immediate costs of testing should be further contrasted with the far greater delayed costs of failure to test and regulate.

Federal efforts are substantial but misplaced — they emphasize cure instead of prevention. And for an environmentally induced disease such as cancer, this is irrational. Health care leads the nation's inflationary spiral, having soared from $30 billion in total national expenditures in 1960 to $185 billion by 1978. In the last five years, the total has grown by 15 per cent annually. In 1978, health care costs were roughly 9 per cent of the G.N.P. and $55 billion more than the defense budget. But as former H.E.W. Secretary Joseph Califano has pointed out, fully 96 per cent of the $48 billion federal expenditures on health care in 1978 were directed to treatment — leaving only 4 per cent for disease prevention programs.

Few would doubt the need to fight inflation, to avoid needless regulation, and to implement only those rules that yield some net benefit to society at large. But the administration's initiatives raise important constitutional and legal issues, particularly as they appear to represent direct executive usurpation of legislative authority.

However, such initiatives are likely to forestall intemperate Congressional antiregulatory sentiments, such as those embodied in the September, 1979 amendment introduced by Senator Dale Bumpers (D-Ark.). Attached to a routine judicial improvements bill, this amendment would switch the burden of proof to agencies who would then be obligated to show "preponderance of evidence" before they could regulate. If enacted, therefore, it would effectively produce regulatory paralysis and declare open season for assault by toxic agents.

Ironically, past Republican administrations have achieved more effective environmental regulation with weak agency heads than has been or is likely to be achieved by the present Democratic and liberal administration aided by strong and progressive agency leadership. Determinants of this paradox include emerging fiscal conservatism, increasing pressures by the administration and industry for deregulation in the name of anti-inflation, the public and Congressional perception of major uncertainties in the scientific base of environmental decision making and risk assessment, and the false issue of freedom of choice being pitted against regulation. In addition, there is concurrently a strong decline in the environmental and anticancer forces in Congress with the recent retirement of Congressmen James Delaney (D-N.Y.), John E. Moss (D-Calif.), and Paul Rogers (D-Fla.), and with the emergence of the new fiscal conservatives. The future role of labor has been made uncertain by recent wage limitations imposed by President Carter, and it is unclear whether organized labor will make wage or environmental controls its main priority. The likelihood of success of the deregulation trend seems enhanced by the absence of an effective national environmental and anticancer constituency.

The Single Greatest Impediment

It is difficult to mobilize a national constituency against carcinogenic products and processes when these hazards cannot easily be quantified and when the penalties of failure to regulate them will be manifest only in 20 years or so. It is simple, however, for an industry to mobilize immediate pressures against the regulation of its activities.

Despite increased funding of federal agencies, priorities on cancer prevention are still low. For instance, only about 10 per cent of the National Cancer Institute (N.C.I.) budget, approaching $1 billion, is spent on research activities that can be reasonably defined in terms of cancer prevention. Additionally, there is no requirement for N.C.I. Cancer Centers to involve themselves in actual cancer prevention — such as carcinogenesis testing, surveillance of high-risk populations, and establishment of tumor registries geared to occupational

and environmental carcinogenic exposures.

The American Cancer Society has been an important element in the distortion of N.C.I. priorities toward cancer treatment rather than prevention, and the society has misled the public into the reassuring viewpoint that there have been major advances in the treatment of cancer. The society has fought against or withheld critically needed support from both legislative (for example, the Clean Air Act, the Safe Drinking Water Act, and the Toxic Substances Control Act) and regulatory (of saccharin, red dye number 2, hair dyes, Tris, DES in cattle feed, and Aldrin/Dieldrin, for example) actions designed to control carcinogens. While the traditional explanation for the society's position on cancer prevention lies in an amalgam of conservatism and ignorance, questions have recently been raised in the press about the possible influence of the wide range of industries in which society directors have direct or indirect financial interests. In any case, it seems unlikely that the society will play an effective role in cancer prevention unless its public image and fund-raising ability are threatened.

The absence of a national public health constituency at a grass-roots level is probably the single most important impediment to serious attempts at cancer prevention. The efforts of public interest groups and organized labor, both of which have been responsible for instigating most regulatory actions against carcinogens over the last decade, are unlikely to prevail in the future unless their spheres of influence can be extended. Important and key additional constituencies that do not yet appear to have been mobilized include senior citizens, on whom the impact of unregulated carcinogens is heaviest in terms of cancer incidence and their ability to meet crippling medical costs, and the church, whose historic mission of social equity needs to be introduced into the debate on disease prevention versus cost.

The costs of current failure to regulate toxic agents will be a crippling inflationary legacy to future generations, and industry will sow a grim harvest of burgeoning cancer carnage unless it develops long-term policies more consistent with public health and welfare.

Suggested Reading

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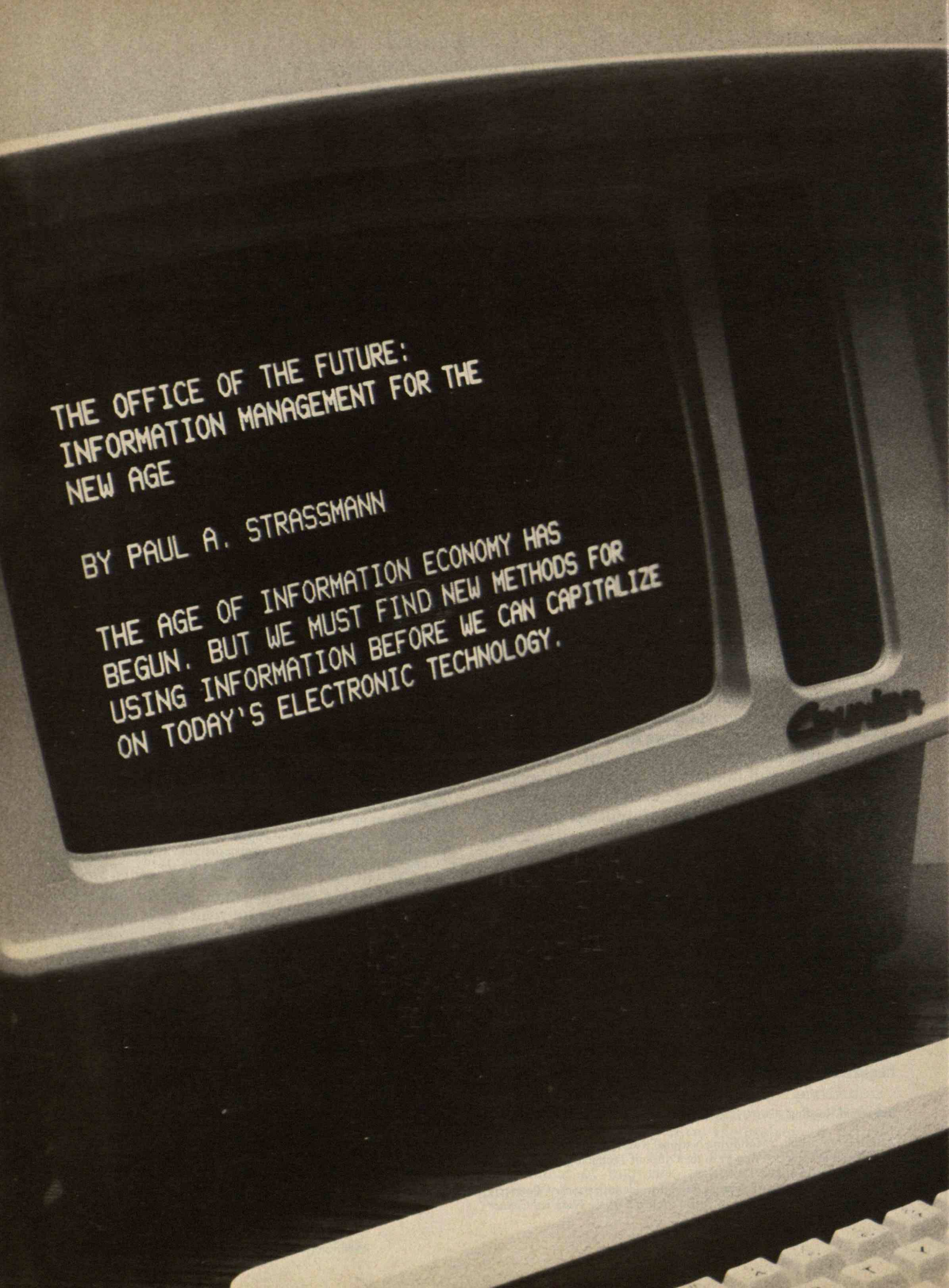

THE OFFICE OF THE FUTURE:
INFORMATION MANAGEMENT FOR THE
NEW AGE
BY PAUL A. STRASSMANN
THE AGE OF INFORMATION ECONOMY HAS
BEGUN. BUT WE MUST FIND NEW METHODS FOR
USING INFORMATION BEFORE WE CAN CAPITALIZE
ON TODAY'S ELECTRONIC TECHNOLOGY.

Why should the productivity of office workers be declining just as powerful new electronic devices capable of performing a variety of information-processing tasks are being placed in their hands?

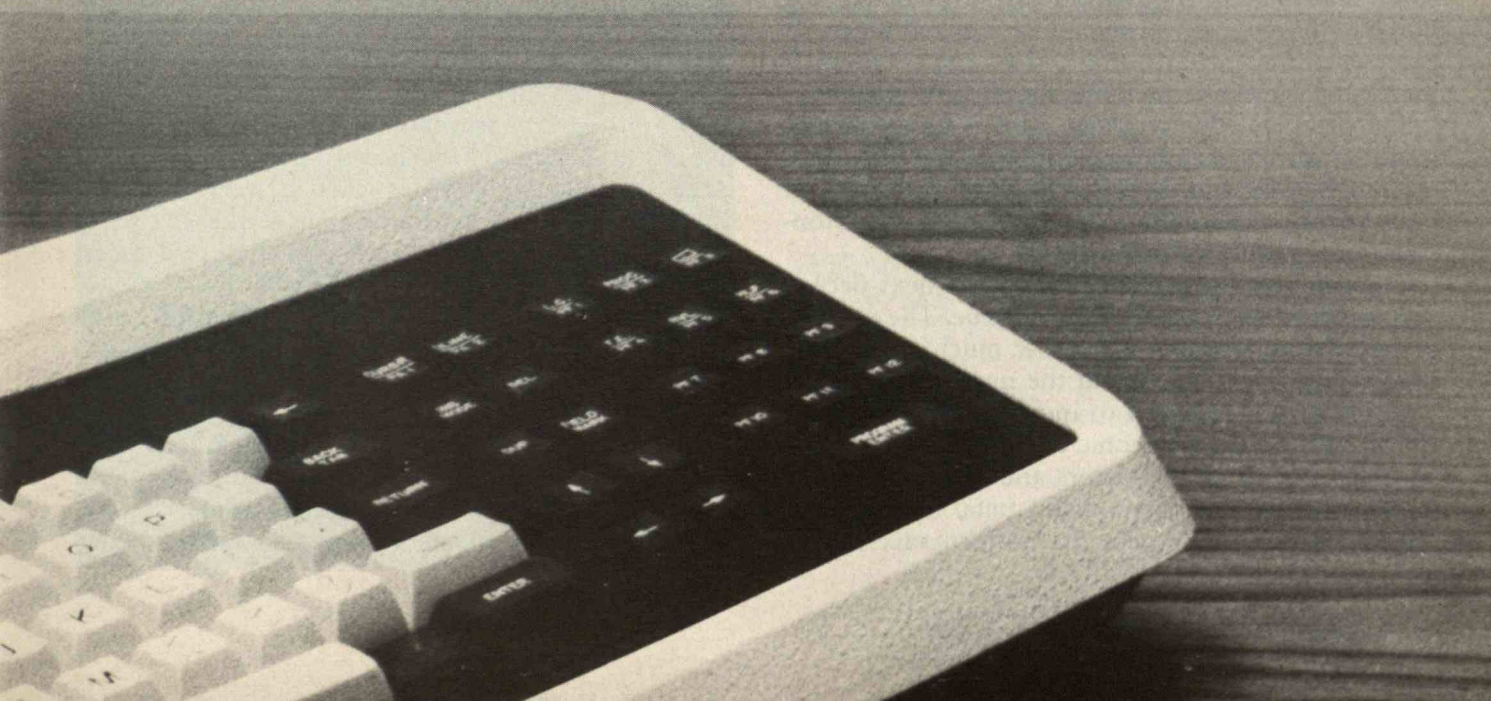
The popular image shows large amounts of new office equipment vastly increasing the efficiency of our clerical, administrative, and even scientific people. It is argued that the ratio of capital to labor costs in offices is only one-tenth to one-twentieth of that in occupations noted for high productivity; by implication, office workers should become more productive as the investment in supporting equipment is increased. So we assume that the move toward the office of the future will be the contemporary equivalent of the industrial revolution, when new technologies were used to dramatically increase manufacturing productivity.

But this transformation from the office of today to a more efficient office of the future seems elusive, and the hypothesized result is by no means assured. Movement toward our new goal turns out to be more difficult and complex than the changes that were necessary for industrialization.

Clearly, the new "revolution" is properly focused on the labor-intensive, time-consuming, frequently wasteful processes involved in originating, manipulating, and disseminating information. But we now lack the insight into concepts of information management that we need to achieve greater efficiency in information handling. Current discussions focus too completely on technological developments; serious planning for the *transition* to office environments where the latent power of computers could be fully realized is being largely neglected.

The Coming of the "Information Society"

Gradually and almost imperceptibly, the U.S. economy since 1940 has been engaged in a transformation that is unique in the history of mankind. By the mid-1950s our working population was predominantly engaged in information handling; more people were involved in the manipulation of information than were employed in mining, growing



Serious planning —
for the transition to office environments
where the latent power of computers
could be fully realized
— is being seriously neglected.

crops, raising cattle, manufacturing goods, or providing personal services. The "information society" became in fact a proper expression of predominant societal characteristics.

Our transition from an agricultural society into an industrial society was greatly aided by the accumulated experience from Europe, where more than three centuries were required to transform the society in a way that ultimately allowed industrialization to triumph. The revolution in which we are now involved is like the one in Europe — without precedent. No other nation has as yet developed the wealth and the goods-producing capacity to afford the luxury of dedicating more than half of its work force to occupations from which no tangible output flows. If we can understand how an information-rich society can function effectively, we will contribute not only to the future prosperity of this country; we will also provide a useful model for others as they approach their transitions to post-industrial societies.

From 1954 to 1974, when the shift toward the information economy was progressing most rapidly, the average rate of expansion of the U.S. work force was exceeded in three categories, "professional and technical workers," "managers and administrators," and "clerical workers." The first two of these occupational categories are designated as "knowledge workers." The large expansion in the clerical labor force was accompanied by large-scale adoption of computers for data processing and information handling, with the result that the knowledge workers became dependent on the clerical workers for support services. As repetitious jobs became automated by computers, ever-increasing numbers of clerical workers, an estimated 60 to 75 per cent, moved into jobs that required ever-increasing symbiosis with the rapidly growing population of knowledge workers. This is an important trend: it means that future opportunities for automation will depend more on fulfilling the needs of knowledge workers than on eliminating monotonous and repetitious clerical tasks.

The outlook for employment in the next decade suggests that these trends will continue. The number of knowledge workers will grow much faster than the average work force, and the number of clerical workers is also expected to increase, despite explosive growth in the electronic data-processing industry. The number of computers and terminals is projected to grow at a compound annual rate of more than 30 per cent. Because the performance of this equipment will be higher than that of its predecessors, the information-processing capability of the U.S. economy may increase at a compound annual rate of more than 100 per cent. Yet economic indicators continue to show that the United States cannot hope to increase its aggregate national productivity much over 2 per cent a year through 1985.

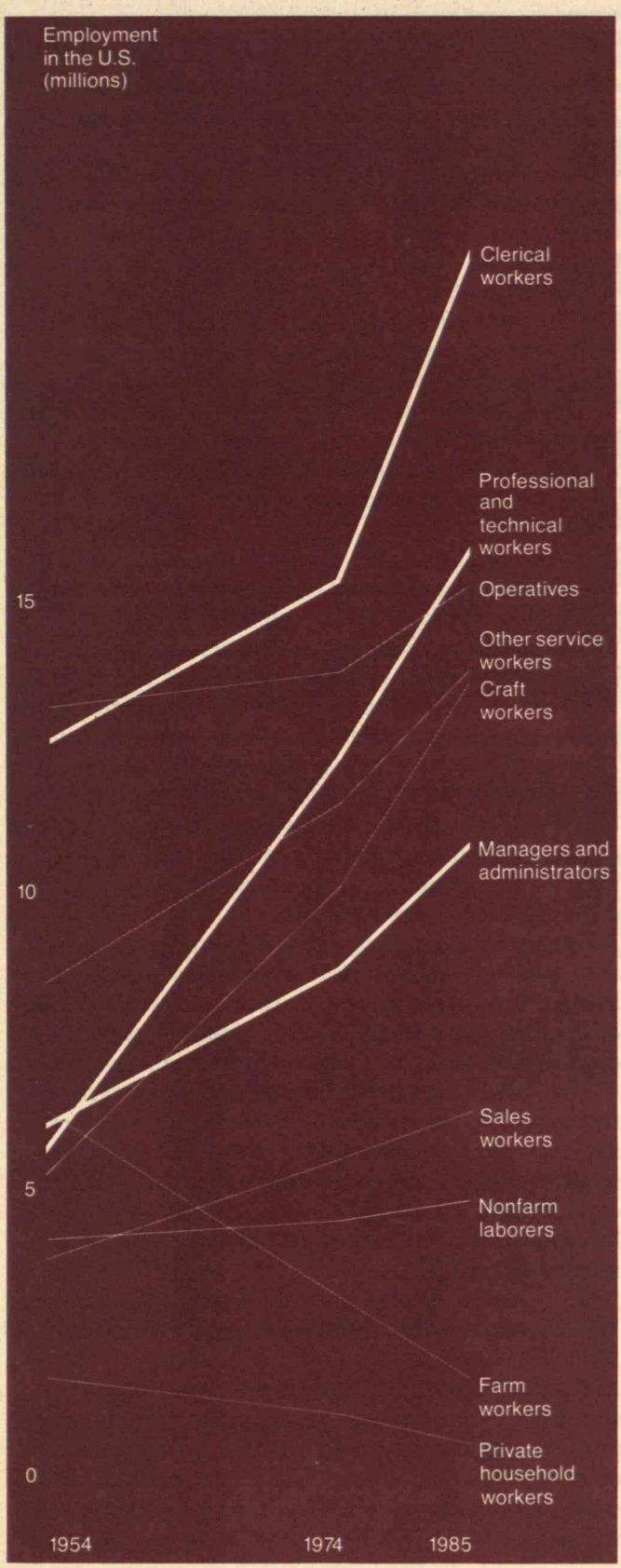
The Proliferation and Productivity of Knowledge Workers

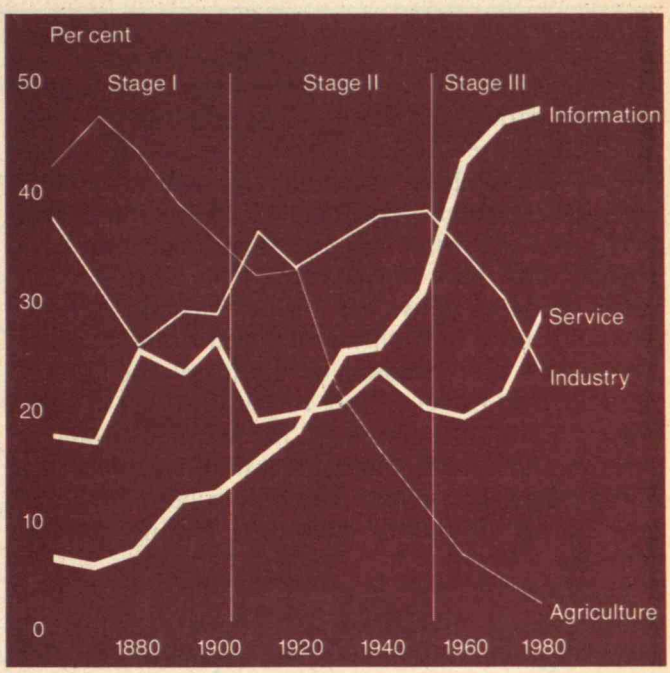
Clearly there is something amiss if diverting workers from industries with high productivity and effective use of capital — such as agriculture, mining, manufacturing, and utilities — into overhead jobs in business and government fails to increase aggregate economic performance as measured by accepted economic indicators. Given the potency of our new electronic technologies, we ought to expect a rather different forecast.

What, then, are the forces that will permit realization of greater information-processing efficiencies? How can the productivity of the government sector, which is entirely made up of knowledge and clerical workers, be increased so that the trend of rising tax burdens on our citizens can be reversed? Must American businesses bear the cost of ever-larger numbers of knowledge workers — attorneys, auditors, accountants, analysts, programmers, engineers, researchers, administrators, and coordinators — along with their support staffs and the tools they utilize? How can we tell whether the immense power of computers is being used to increase profitability or simply to generate unnecessary information?

The answers to these questions lie in the fundamental issue of how we employ our knowledge workers. They are an increasingly numerous elite who control every aspect of our social and economic lives by managing the division of specialists' labor in large organizations. Their cost is very high — $50,000 to $80,000 per knowledge worker per year, over $30 an hour. This figure has increased more rapidly than average wage rates because new office amenities, fringe benefits, pension privileges, and generous education allowances as well as increasing support staffs must be directly allocated to the total expense.

Unfortunately, the results that are achieved by a knowledge worker cannot be measured in terms of product or profit. The only available measure is of hours of labor expended. Thus the allocation of the





Above:
The coming of the information era. Since 1960 more people in the United States have been involved in manipulating information than in growing food, manufacturing goods, or providing personal services. As our information-management problem has grown, the productivity of the society — and especially of its information workers — has decreased. The resolution of these frustrations, says the author, awaits the development of the office of the future.

Left:
The growth of the information economy. U.S. employment trends show rapid expansion in three job categories: professional and technical workers, managers and administrators, and clerical workers. The first two are the knowledge workers, whose principal tasks involve the handling and use of information; clerical workers are their chief assistants. The trends are predicted to continue into the 1980s. (*Source: Monthly Labor Review*)

The overall volume of information is growing at a rate far exceeding the growth of our labor force. So we are experiencing exponential growth in information overload.

time of knowledge workers is of pivotal importance to anyone responsible for their management.

Though there is some variation from organization to organization and from job to job, surveys show that knowledge workers spend the major portion of their time absorbing or giving information verbally. Only a very small percentage of their time is typically given to "thinking" (less than 8 per cent) or to writing (less than 10 per cent). The most frequent single mode of activity is formal meetings (20 per cent and more in highly structured organizations); two-person conversations on the telephone (5 to 10 per cent) and travel (about 10 per cent) are also important. The proportion of intraorganizational to extraorganizational communication varies over a broad range; knowledge workers in large organizations spend almost all their time talking amongst themselves.

Electronic devices currently available have little direct leverage on the heavy communication loads of knowledge workers. Indeed, the impact of office automation on their personal working habits has been negligible. This is because the communication of knowledge workers is largely unstructured and ill defined. Where memoranda, reports, or procedures are needed, the bulk of the labor is delegated to supporting clerical or specialist staffs; here word processing, text editing, dictation, and facsimile equipment has a definite role. But the idea of automating the illusive, nonstandard, and ever-changing communication patterns of knowledge workers remains difficult.

How Information Grows Faster Than Its Users

To date, much of the quest for increased productivity in information-handling organizations has been propelled by ideas derived from industrial experience. The goal of most electronic data-processing projects has been to standardize unit transactions so that computers could perform complex functions built up from essentially simple elements.

The existing bureaucracies fostered this approach because their established structures were already tuned to breaking down information-handling problems into smaller and smaller components. Such an administrative bureaucracy always seeks to improve efficiency by standardizing unit transactions and automating individual functional tasks at their lowest level. For instance, administrators will see that a highly standardized system is set up to deal with order entry, order validation, and related contractual matters between a department and its customer. These include countless standardized internal communications involving credit, invoicing, and other policies within the finance area, as well as the final communication to the customer.

In certain administrative structures such communication methods are indeed increasing efficiency and thus increasing the aggregate productivity of the organization. This is especially likely to occur in situations where:

☐ The activities are relatively simple and easily standardized, such as in banking, order entry, merchandising, and parts management.

☐ The patterns and contents of transactions are relatively stable, so that procedural relationships among the various units can be updated as conditions change. Airline reservations systems are an example.

☐ A reasonably large volume of transactions allows amortization of the fixed costs of automation across a large base. Payroll and invoicing transactions typically exhibit these desirable characteristics.

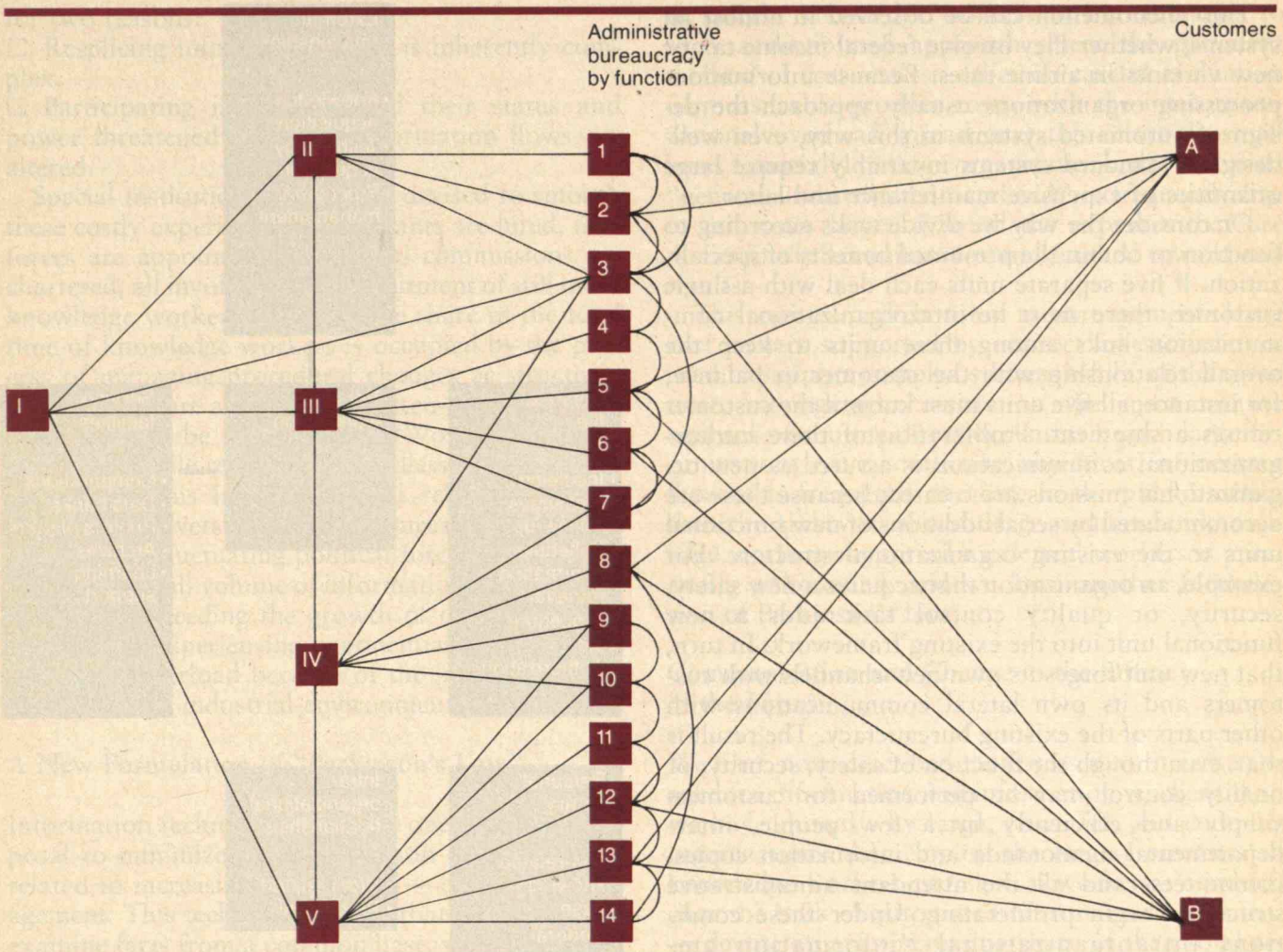
☐ A fairly simple system for analyzing the cost and value of service is in place, so that management can understand the complex trade-offs between various alternatives for achieving adequate performance at the lowest cost. Typically, a small company or operating division in the private sector best exhibits these attributes; payoffs from investment in information-handling automation are easiest to understand in this environment.

The rapidly decreasing cost of computer hardware and software means that ever-larger numbers of applications that meet these four criteria are candidates for automation. Thus simplification, standardization, and automation are proceeding rapidly.

The proliferation of computer hardware and software also means that many information workers are engaged in activities that do *not* meet these criteria. Instead of increasing efficiency, they are contributing to today's information overload by helping generate redundant information in ever-increasing quantities.

The Growth of "Information Amplification Factors"

As noted above, bureaucracies tend to favor simplicity, standardization, stability in procedural patterns, uniformity, and breakdown into smaller components. But when pushed beyond a critical scale, such efforts toward simplicity yield complexity instead.



How today's typical large organization copes with its information-handling tasks. The administrative bureaucracy is typically organized by mission: its various functions are carried out in compartmentalized groupings. In turn, each of these functions is further subdivided into units with specific missions. At higher levels are aggregations into departments, divisions, directorates, and so forth. A typical large federal agency may thus have as many as 8 to 14 layers between its clients and top management; large corporations commonly have 5 to 9 organizational layers to coordinate functional specialization.

The problems of increasing complexity are manifold. For example, if customer B declines an order, that information must go to the sales department (2), the credit department (5), the invoicing department (6), the consumer relations section (7), the product design department (12), and the quality control department (13). From each of these the information proceeds in turn to the marketing division (II), the finance division (III), the public relations division (IV), and the research and development division (V). Communications among these agencies proliferate as their numbers increase — and especially as data-processing managers attempt to standardize messages and transactions.

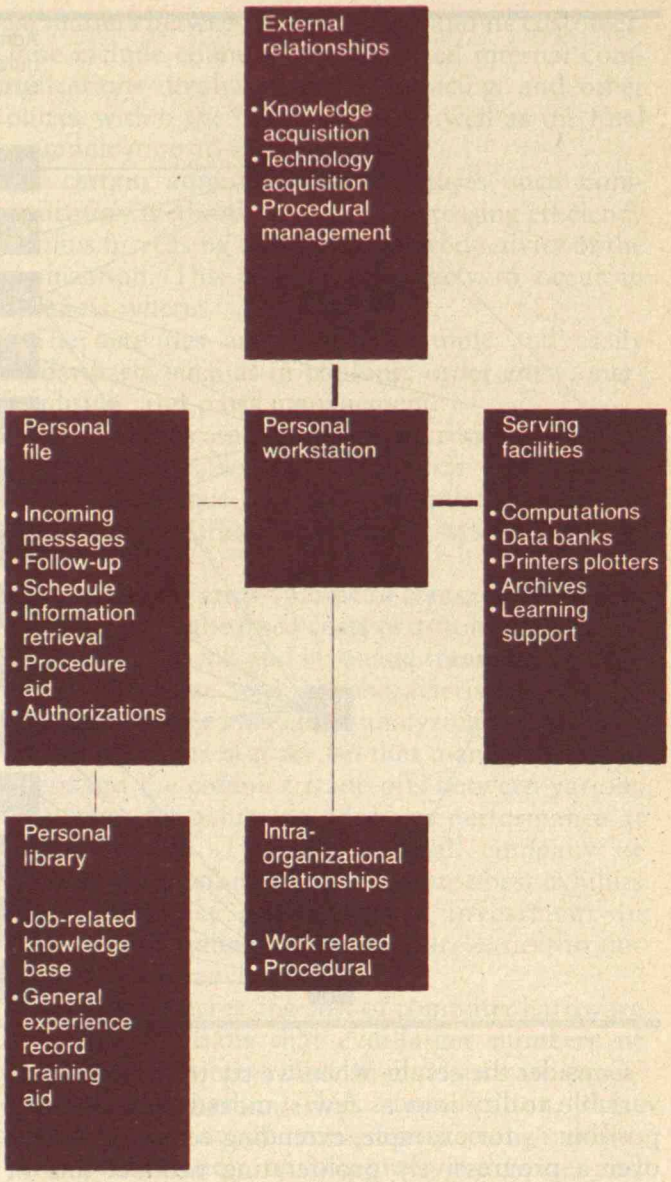
Consider the results when we try to force a highly variable reality into as few standard procedures as possible — for example, extending central invoicing over a progressively proliferating product line or customer set. Ever-larger computer programs and ever-thicker procedure manuals are required to permit a standard process to accommodate unique or special situations.

As a result, additional clerical and administrative labor is needed to deal with the errors, inconsistencies, and exceptional cases generated by the central system as it strives to resolve an ever-increasing number of special conditions. Such errors or special cases may be very costly — 20 to 50 times the cost of the common transaction for which the system was designed. Though we are trying to achieve economies of scale in processing, we instead gradually increase the complexity and cost of what used to be a simple process.

This phenomenon can be observed in almost all systems, whether they involve federal income tax or new variants in airline rates. Because information-processing organizations usually approach the design of automated systems in this way, even well-designed standard systems invariably require large quantities of expensive maintenance and labor.

Or consider the way we divide tasks according to function to obtain the presumed benefits of specialization. If five separate units each deal with a single customer, there must be intraorganizational communication links among these units to keep the overall relationship with the customer in balance; for instance, all five units must know if the customer refuses a shipment. Proliferation of these intraorganizational communications is assured as new organizational missions are created, because these are accommodated by serial additions of new functional units to the existing organizational structure. For example, an organization that acquires a new safety, security, or quality control task adds a new functional unit into the existing framework. In turn, that new unit forges its own new channels with customers and its own lateral communications with other parts of the existing bureaucracy. The result is that, even though the function of safety, security, or quality control may be performed for customers simply and efficiently by a few people, interdepartmental memoranda and information copies, committees, and all the attendant administrative structures begin proliferating. Under these conditions intraorganizational "information amplification factors" of 40 to 1 are not uncommon — that is, for every one communication or transaction with a client or a customer, the organization may have to generate more than 40 internal messages to keep the various functional units apprised of what's going on.

The neat and efficient relationships implied by the typical functional chart (*see page 59*) deteriorate rapidly if the pattern and content of procedures are not stable. Adjusting to procedural change in a large and complex administrative bureaucracy is especially difficult. Interdepartmental relationships not only reflect the need for specialized components to act in unison; they also reflect the relative clout enjoyed by each component. This clout is directly translatable into status, budget appropriations, authority, and precedence in decision making. When structural relationships in an organization are altered for any reason, the process of readjusting communication links is costly and time consuming



The information middleman's personal work station. The key to the success of this middleman is his/her quick access to whatever information he/she needs, including the company's (and society's) legal and procedural conventions for conducting business. Powerful electronic equipment will be required, and some of today's conventions may have to change — especially those involving personal and financial transactions.

for two reasons:

☐ Resplicing information flows is inherently complex.

☐ Participating individuals find their status and power threatened whenever information flows are altered.

Special institutional forms are devised to smooth these costly experiences. Consultants are hired, task forces are appointed, and special commissions are chartered, all involving the commitment of still more knowledge workers. Thus a large share of the total time of knowledge workers is occupied by the process of managing procedural changes as structures and missions are adjusted. The often-quoted Parkinson's law can be paraphrased: "Work increases to use up available resources, regardless of real jobs to be done." This law has special relevance to the power maneuvers found in a bureaucracy that is subjected to fluctuating political forces.

So the overall volume of information is growing at a rate far exceeding the growth of our labor force and we are experiencing exponential growth in information overload because of the increasing complexity of our industrial environment.

A New Formulation of "Parkinson's Law"

Information technology has only one tool at its disposal to minimize the proliferation of information related to increasing complexity — data base management. This technique assures that all parties will examine facts from a common base, which is clearly helpful in cases where adjustments of operational procedures are to be made. But the large majority of structural changes do not lend themselves to such an explicit method of analysis, and it is clear that organizations that are prone to changes in policy, such as most of our federal agencies, spend a disproportionate amount of their total effort in activities aimed only at maintaining a viable internal equilibrium.

The most wasteful cases of modern information management are encountered when organizations have neither means for measuring the total costs for processing transactions nor means for assessing the value of services delivered to clients. Total transaction costs are well understood in the private, competitive sector in which information service is delivered as a product — for instance, in a consulting firm — because the commercial viability of the enterprise is vitally affected by its ability to manage its fixed and variable costs. But it goes against tradition to subject knowledge workers in bureaucracies to such a disciplined approach. Here the prevalent method of cost analysis relies on careful evaluation of measurable product costs, with the interorganizational overhead spread over this relatively small base. Especially in large organizations, this so-called "general undistributed overhead" is frequently five to ten times larger than all the expenses that are meticulously accounted for and tracked toward end results.

This creates a dichotomy in management: large cost centers supported by indirect assessments are used to support complex systems while, at the same time, management insists on the most minute analysis of routine direct expenses. If such large organizations have conflicting objectives in constant flux, as is frequently the case in the public sector, then the ability to absorb large numbers of knowledge workers supported by clerical workers is practically unbounded, and we have another formulation of Parkinson's law.

Communication and Change in the Office of the Future

We have now described the forces that increase the need for information and information workers. And we have shown why large, powerful, and complex organizations that employ the largest numbers of knowledge workers and clerical workers — and engage the bulk of automated information equipment — devote an ever-increasing share of their total resources to managing internal overhead.

The office of the future will be based on that set of concepts and technologies that will allow us to cope with these frustrations and limitations in existing standardized administrative systems.

Though the office of the future must rely on computer technologies to achieve its objectives, it represents much more than an extrapolation from present experiences with the automation of standardized clerical tasks. To enhance the effectiveness of knowledge workers, the limitations of existing information structures must be overcome.

These are the requirements for achieving major improvements in productivity for managers, technical workers, and administrators:

☐ Information management tasks that are now delegated by knowledge workers to their clerical administrative assistants — for instance, the great variety of informal communications between the managers and their secretaries — must be handled by

Information must become a commodity in a world market, available to information middlemen at the prevailing price.

electronic means in ways that reduce the amount of labor expended.

☐ Procedures currently embodied in written manuals or in custom must be somehow embedded within electronic networks. Changes in communications made necessary by new procedures or changes in relationships could then be accomplished without ambiguity and without the time-consuming negotiations now needed to achieve interorganizational equilibrium.

If these two steps can be achieved, the time available for knowledge workers to serve customer and client needs and to innovate in these services can be considerably increased.

Many major innovations are essential before this office of the future can materialize. Greater material productivity in the industrial revolution was made possible by a large set of simultaneous innovations in technology, organization, communications, and even basic thinking. So, too, will the transition to an information society require changes in institutions as well as in technology and its infrastructure.

I will focus here on three elements of change that are pivotal to more productive use of our information-handling resources.

The Information Middleman

A way must be found to increase the time available to knowledge workers for serving their clients and customers. The single largest opportunity for achieving this objective is in reduction of the time devoted to intraorganizational overhead activities.

We now understand that systems that provide services to external agencies and that have low internal communications loads are best organized in decentralized and adaptable forms. Translated into the business context, this suggests the possibility of an adaptable, decentralized information link.

We call this new means for simplifying communications an "information middleman" because he/she can communicate with any of the functional elements of the bureaucracy and represent all those elements to any number of clients or external agencies. Thus he/she represents, in miniature, all the services provided by the enterprise to its customer. Specialists still have their place in the functional units, where their skills will be available. But the load of information coordination within the bureaucracy is greatly eased because the responsibility for the client's problems is at a single desk, not amorphously distributed among many.

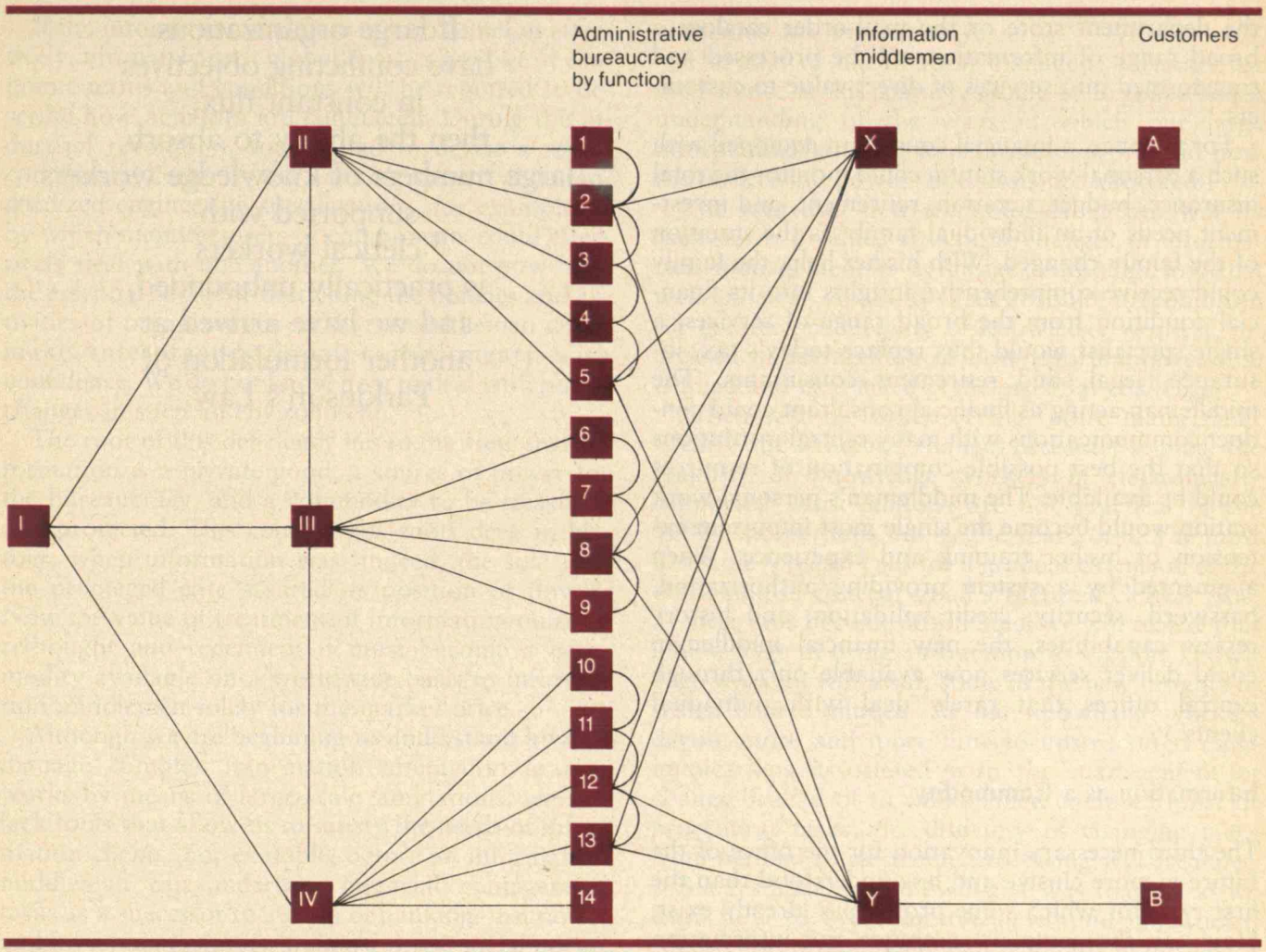
The existing airline reservations system is a classic example of such an information middleman function augmented by computer networking technology. A customer can approach a single representative of any airline — an information middleman by our definition — and complete the entire process of booking and paying for flight reservations, interline connections, and hotel and rental car reservations. From the standpoint of productivity, the system is a marvel of efficiency; without this decentralized execution by an information middleman supported by centralized resources, today's large volume of air traffic would be impossible. Even though the airline reservations system seems to be simple, standardized, and well understood, it is worth recalling that the industry required more than 15 years of evolutionary development to put the current global reservations network in place.

This same strategy of locating the coordinative workloads outside the bureaucracy, at direct contact with the client, offers opportunities in a number of situations where current administrative methods are virtually powerless. Consider, for instance, the welfare-client relationship. At present, a welfare applicant may spend an enormous amount of time approaching various federal, state, and/or local agencies to establish eligibility and needs; the process is incredibly complex. A recent White House task force studying the question recommended the use of information middleman — welfare case workers who are able to handle all of an individual's needs. The concept is to increase the ability of the individual case worker to handle a broad range of assistance programs without being an expert in any of them. The trade-off between specialized expertise and generalized ability is decided in favor of the latter because it offers responsive handling of clients' needs, and there is good communication with specialized expertise when needed.

The Middleman's Computerized Work Station

The information middleman's commodity is information, and to process it efficiently he/she will need highly individualized computer capability. Thus the second major innovation that must be realized before the "office of the future" can make our knowledge workers more productive is the personal "work station" to help the information middleman deal with the specialists whose knowledge he/she needs (*see chart, page 60*).

That knowledge, which today is transmitted in the



The crucial role of the information middleman. To resolve the problems of increasingly complex information-handling functions, the office of the future will be equipped with information middlemen. Each such middleman will be able to communicate quickly and effectively with the specialists he/she needs, and each middleman will deal with all a client's needs — whether they involve sales, financial services, or product design. The duplication of intracorporate communications will be sharply reduced.

informal communications among knowledge workers, will in the future be structured into computer logic representing the legal and procedural conventions for performing a set of services. This means that both formal policy manuals and informal procedures will be embedded into each work station. The information needed to perform a broad range of customer services will be readily available where it is most needed. The information middleman is now freer to respond to customer needs, and he/she has before him/her the well-defined limits set forth by specialists who are responsible for maintaining the professional quality of each activity at the lowest possible cost.

The ultimate objective is to extend the expertise of the information middleman so that he/she can interact with ever-increasing communities of specialists, ultimately worldwide. Each information middleman thus will become a personal analog of

the department store or the mail-order catalog: a broad range of information will be processed and transformed into services of direct value to customers.

For instance, a financial consultant equipped with such a personal work station could monitor the total insurance, budget, taxation, retirement, and investment needs of an individual family as the situation of the family changed. With his/her help, the family could receive comprehensive insights into its financial condition from the broad range of services, a single specialist would thus replace today's tax, insurance, legal, and retirement consultants. The middleman acting as financial consultant could conduct communications with many central institutions so that the best possible combination of resources could be available. The middleman's personal work station would become the single most important extension of his/her training and experience. When augmented by a system providing authorization, password, security, credit validation, and history review capabilities, the new financial middleman could deliver services now available only through central offices that rarely deal with individual clients.

Information as a Commodity

The third necessary innovation for the office of the future is more elusive and less understood than the first two, for which some prototypes already exist. How can the complex computer and information networks of the future and the many loosely arrayed middlemen interact without creating chaos? How could structural realignments and changes in procedures be accommodated? For example, how could welfare systems be transformed so that the separate jurisdictions — federal, state, and local — do not frustrate the information middleman's goal of providing welfare services rapidly and responsibly?

This question raises a host of technical issues involving telecommunications protocols, data definition conventions, access to distributed data bases, protection of privacy, security against fraud, and indexing of information. There is also the difficulty of making sure that the learning levels of all the people interacting in the networks are reasonably synchronized. And finally, the most difficult problem arises: How can individual bureaucracies be persuaded to express their procedures unambiguously, and how can they agree on changes more gracefully and at a lesser cost than they do now?

If large organizations have conflicting objectives in constant flux, then the ability to absorb large numbers of knowledge workers supported with clerical workers is practically unbounded, and we have arrived at another formulation of Parkinson's Law.

If the information middleman is to function effectively, ultimately on a global basis, a new set of economic terms and conditions will be required to describe how activities are conducted. During the industrial revolution, society had to devise a set of commercial codes — the banking system and standardized engineering specifications, for example — by which manufacturers of components could effectively deal with one another. We do not now have the essential tools for describing the policies and activities of organizations so that a middleman could make interorganizational commitments with confidence. We do not know how to deal with policy changes in such an environment.

The root of this deficiency lies in the view that information is a private good, a source of power for the bureaucracy, and a commodity to be treasured and protected. This concept has roots deep in history, when information was, indeed, the sole way the privileged elite assured its position of power. Now the value of treatment of information must be rethought and redefined; it must become a commodity available on a worldwide basis to information middlemen solely for the market price.

Although we are beginning to understand how to manage complex information interaction in networks by means of large-scale simulations, we still lack tools that allow us to satisfy the needs of information clients. For example, before an information middleman can undertake financial management tasks as a successor to a team of banking, insurance, and investment experts, we must revise social norms about privacy, individual responsibility, and legal accountability. Only then will the proper institutional setting exist for vastly more productive knowledge workers to act as information middlemen. These problems are particularly acute in areas involving the satisfaction of human needs — health care, welfare, financial security, and education.

A Revolution in Information

The office of the future is a concept revolutionary to the development of our post-industrial society because it can potentially redefine how the largest part of our working population functions. This concept should therefore not be viewed simply as a means for overcoming existing technological limitations; it should be seen as a restructuring of the thinking and working methods of professionals, managers, and administrators. It is a proposal for a social environment in which information flows are managed in a conscious and explicit way.

The goal of information managers, certainly for the balance of this century, should be to gain a better understanding of the ways in which our large information-handling bureaucracies work and how the underlying powers and costs are allocated.

The idea that new technological means will by themselves produce structural changes in information management is a mirage. Although low-cost technological capability is an absolute precondition for greater productivity of knowledge workers, increased understanding of how information can be defined and channeled is the essential challenge.

When will the office of the future materialize? Clearly, the structural changes necessary to place the majority of knowledge workers in electronically supported work stations are not practical in the 1980s and perhaps not by the year 2000. The most probable forecast calls for a gradual extension of the work-station concept to all structured clerical jobs; as these jobs become automated, we will realize that a new stage in using automation to support knowledge workers will await some of the new insights to which I have alluded. As our knowledge workers devote more and more time to unstructured communications associated with the management of change instead of to well-defined computational or procedural tasks, the difficulty of changing tasks from manual to electronic processing will escalate.

But gradually turmoil will give way to order as we learn how to overcome the newfound limitations. All this will probably happen gradually in the next 5 to 15 years, when the current concentration on word processing, text processing, and distributed computing will run its course. At that point, the era of the personal work station as the principal means for interorganizational communications for the majority of white-collar workers will be possible. When this happens, we will explore new horizons and encounter new experiences in intergroup coordination for which nothing in the past has prepared us. Clearly, the age of the information economy will finally have dawned.

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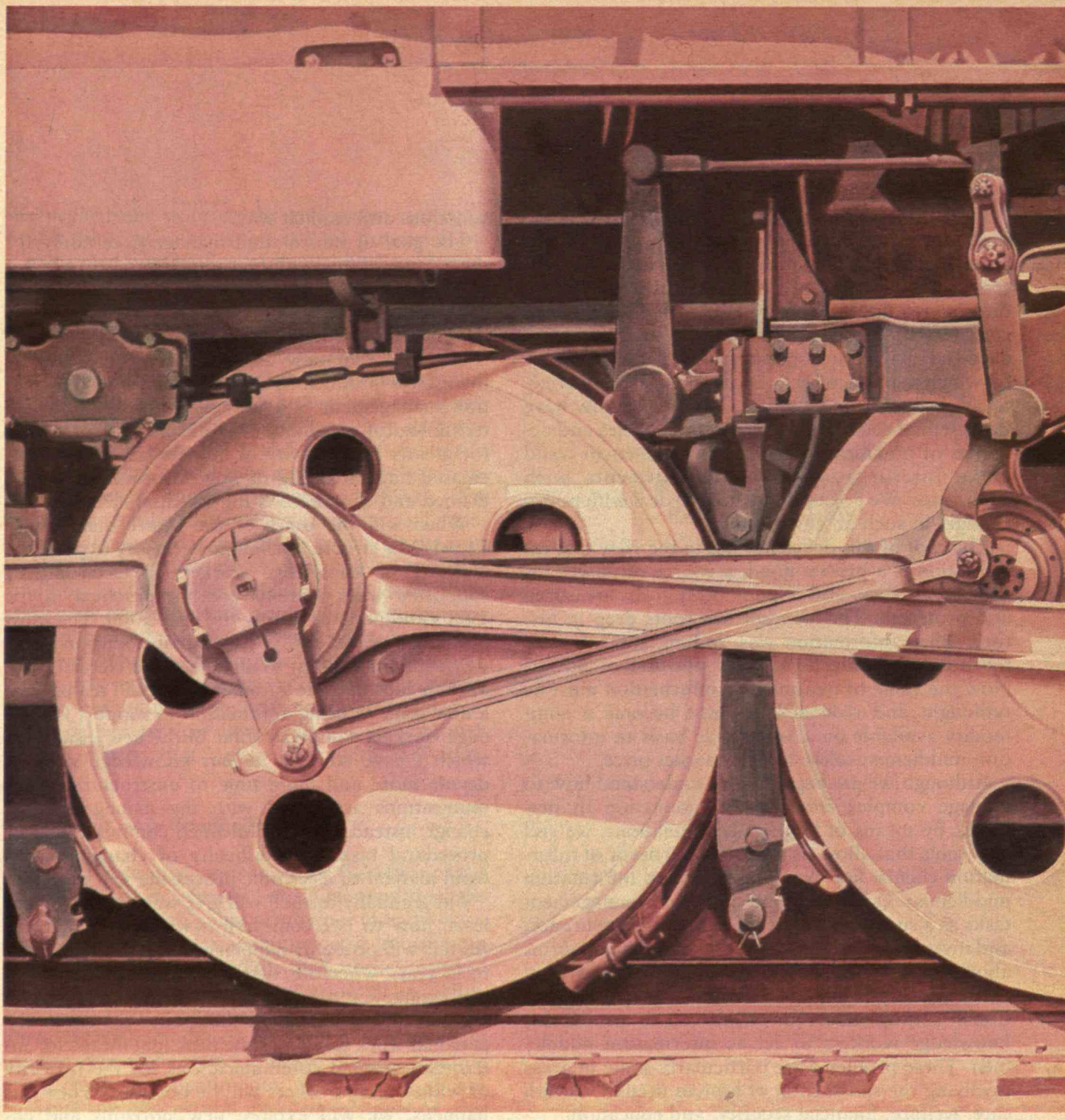
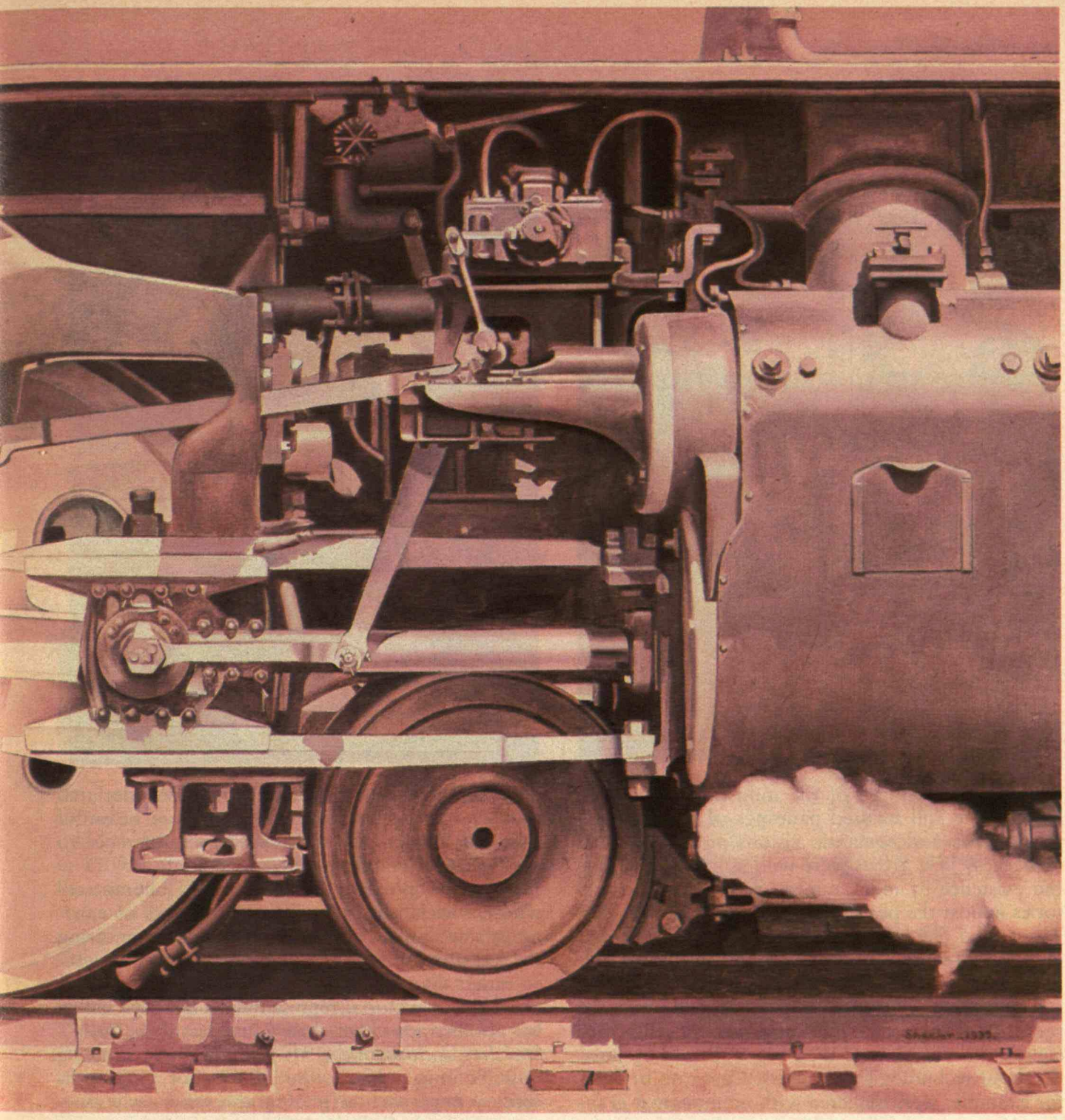


Artists have ignored, vilified, satirized, tolerated, admired, worshipped, abstracted, used, and created technology in their work.

Artists on Technology

by Julie Wosk



Since the beginnings of the industrial revolution in the late eighteenth century, artists have celebrated and satirized, extolled and excoriated the technological developments of the modern age.

Artistic images of technology often mirror public views, and with each advance in technical knowledge — from the proliferation of ironworks to the use of telecommunications and computers — artists have recorded prevailing social attitudes of both attraction and antipathy. Early recorders of industry presented the satanic as well as the picturesque aspects of new technologies, and factories were seen both as the image of beauty and a vision of hell. During the twentieth century, artists have become increasingly sophisticated in depicting the admirable as well as the fearsome aspects of the machine age. Since the 1960s, many have collaborated with scientists and engineers in projects of mutual interest.

Charles Sheeler. *Rolling Power.* 1939. Oil on canvas 15 x 30″ (38.1 x 76.2 cm). Smith College Museum of Art, Northampton, Mass.

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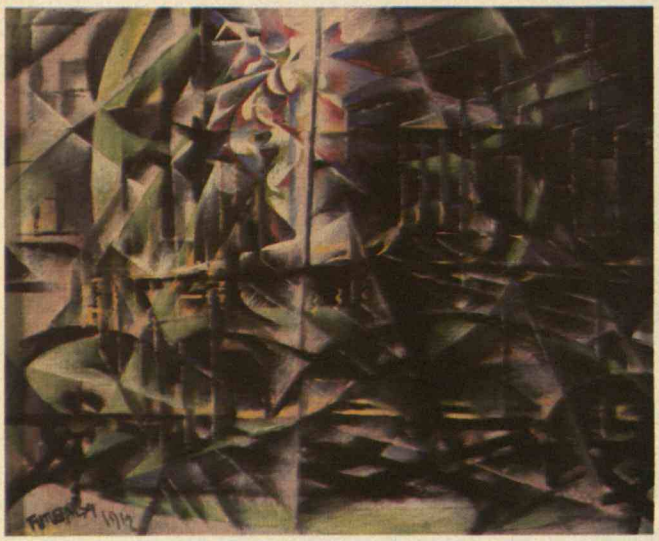

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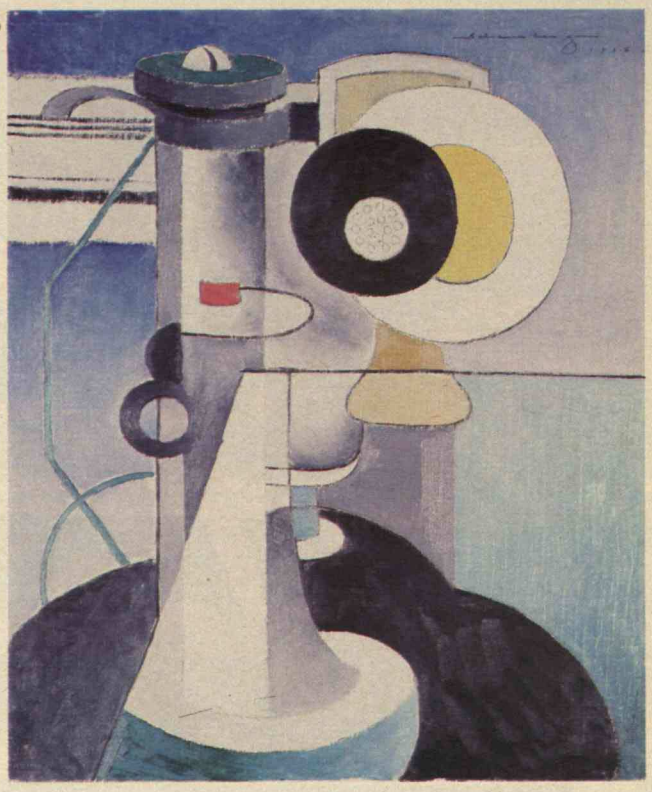

In the early stages of the industrial revolution, public taste still favored paintings of tranquil pastoral scenes and romantic visions of an unspoiled wilderness; few artists were willing to acknowledge the existence of mills, mines, ironworks, and factories amidst the peaceful villages and countrysides. Those who did treat technology endowed it with a diabolical quality — red lights, sulfurous fumes, polluted waters, and atmospheric gloom.

There were, however, artists who admired the technological achievements during the late eighteenth century, and their work seemed optimistic about technological progress. Cast-iron bridges, for example, were depicted with monumental grandeur, fitting gracefully within natural surroundings; iron forges were seen as beautiful and even romantic, with their glowing silhouettes cast against the night sky.

In 1910, a group of Italian artists who called themselves Futurists were among the first to make a commitment to technology a major part of their work. Issuing dramatic manifestos, they demanded that the old subjects — landscapes, nudes, classical myths, and historical events — be abandoned in favor of new technological achievements: "All subjects previously used must be swept aside in order to express our whirling life of steel, of pride, of fever, and headlong speed." One Futurist writer declared that "a roaring automobile . . . is more beautiful than the Victory of Samothrace" — a reference to the Greek statue of the winged victory.

Futurists glorified "deep-chested locomotives whose wheels saw the tracks like hooves of enormous steel horses." They were intent on capturing the feel of motion — "the dynamic sensation itself" — rather than a single frozen moment. They recognized that a pictorial representation of speed called for an abstract rather than a realistic style. Balla's *Speeding Automobile* (1912), for example, with its multiple images, shows the influence of nineteenth-century experimental photographs and early cinematography (*see above, left*).

While the Futurists extolled the motion and energy of modern technology, others admired the simplicity, clean edges, and geometric shapes of machine-made, mass-produced objects. Morton Schamberg's asymmetrical compositions reveal that machine parts are inherently abstract and beautiful. His painting *Telephone* (1916) (*above*) presents a bold and striking vision of the manufactured object without any symbolic or satiric overtones. Schamberg was not always so straight-faced in his artistic views, however. Seeing the humorous side of the machine age, he created a "sculpture" of a plumbing

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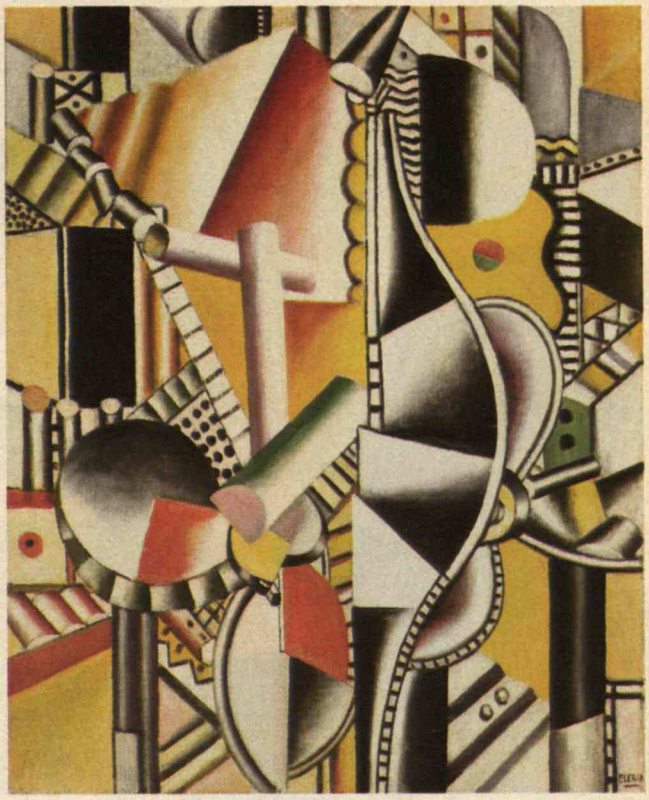

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trap mounted on a miter box, entitled *God* (*see above*).

Geometric abstraction, which gained momentum in 1909 with the early paintings of Cubists such as Picasso and Braque, became one of the dominant styles of the twentieth century. French painter Fernand Leger created abstractions of machinery, as seen in *Propellers,* as well as people with bodies of cylinders, pistons, cones, and spheres, and faces of metallic gray (*see above, right*).

Another movement known as Dada spoofed the pretensions of art and the absurdities of modern technology. Dada champion Marcel Duchamp created a sensation in 1917 when he exhibited a urinal entitled *Fountain*. Another Dadaist, Francis Picabia, satirically transformed machine gears into human beings. *Machine Tournez Vite* (1916-17), or *Machine Turn Quickly*, presents interlocking wheels discreetly labeled "male" and "female."

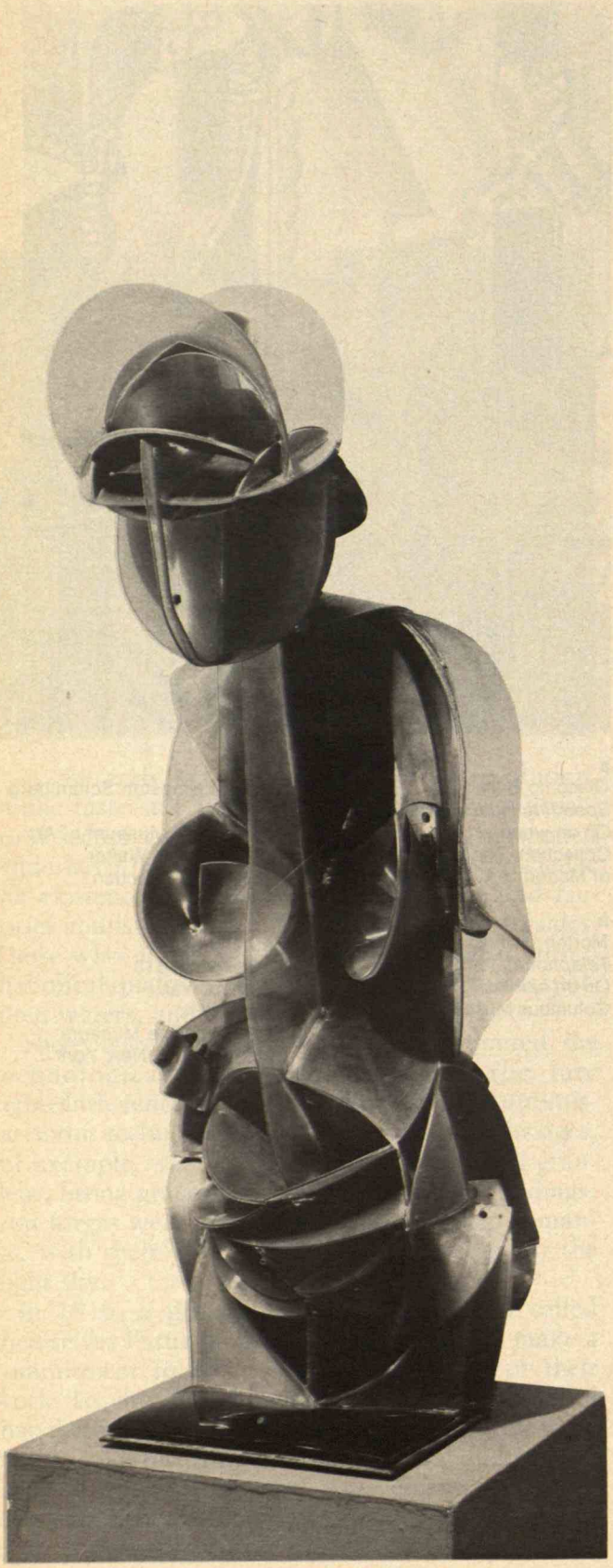
The Dadaists' mockery seemed to have little impact on the prevailing attitudes and taste of the 1920s and 1930s in Russia, Western Europe, and the United States. The Soviet Constructivists embraced the technologies that they hoped would drive their new revolutionary society, and they based their art on the geometric forms and materials of industry. Antoine Pevsner's sculpture *Torso* (1924-26)

a
Giacomo Balla
Speeding Automobile. 1912
Oil on wood, 21⅞ x 27⅛"
Collection, The Museum
of Modern Art, New York

b
Morton Livingston Schamberg
Telephone. 1916
Oil on canvas
Columbus Museum of Modern Art

c
Morton Livingston Schamberg
God
Philadelphia Museum of Art:
The Louis and Walter
Arensberg Collection

d
Fernand Leger
Propellers. 1918
Oil on canvas
31⅞ x 25¾"
Collection, The Museum
of Modern Art, New York



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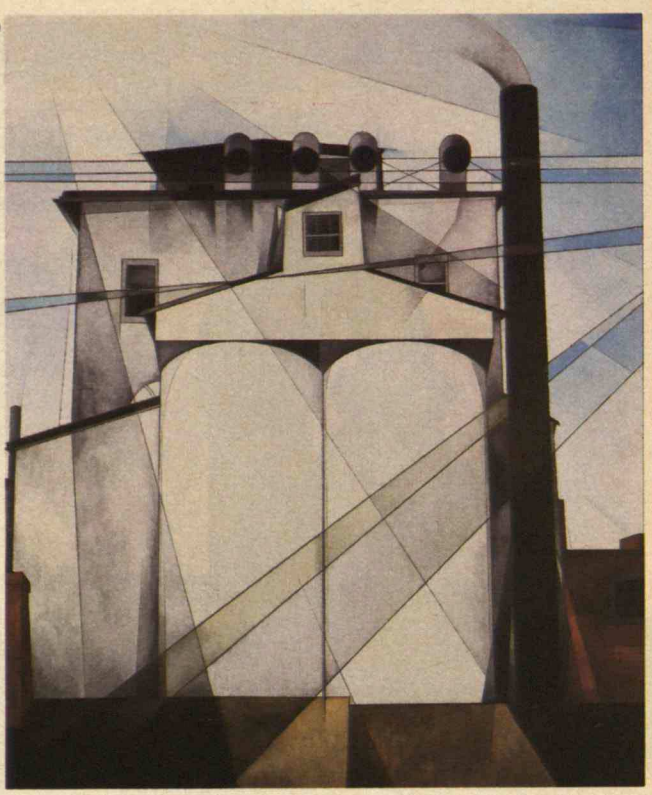
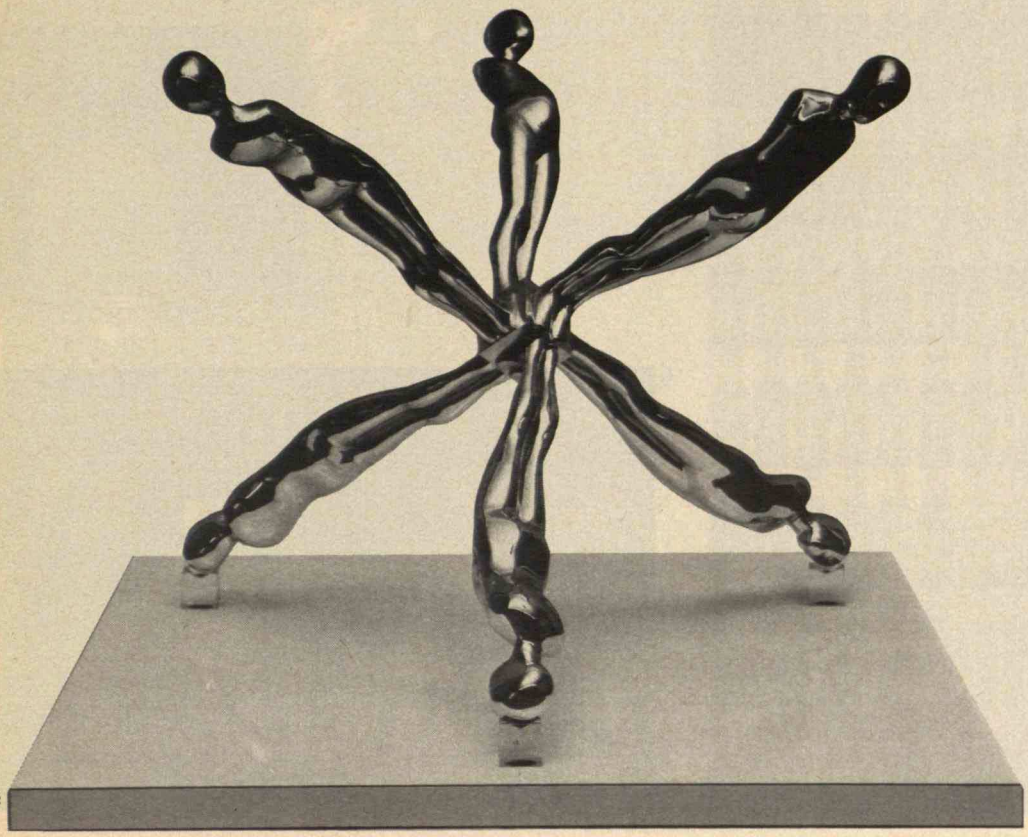


(*left*) makes early use of plastic and renders the human body with machine-part precision. Noam Gabo, Pevsner's brother and an engineer and mathematician, began to utilize unconventional materials such as glass, plastic, and steel in his sculptures. They described their approach as follows: "Plumb line in hand, our gaze straight as a ruler, our mind as inflexible as a pair of compasses, we construct our work . . . in the same way that the cosmos constructs its work, the engineer constructs his bridge, or a mathematician constructs his formulas."

Industry as Art

The admiration and respect for machine technology shown by the Constructivist artists was also reflected by the Precisionists (or Immaculates, as they were also called), who painted highly detailed pictures of industrial plants and machinery, each work revealing an almost worshipful attitude toward mechanization and industry. Charles Sheeler's painting *Rolling Power* (1939) focuses on clearly delineated railroad wheels that — when in bright light and free of any grease, grime, or rust — become a marvel of strength, technical ingenuity, and aesthetically balanced forms (*see page 66*).



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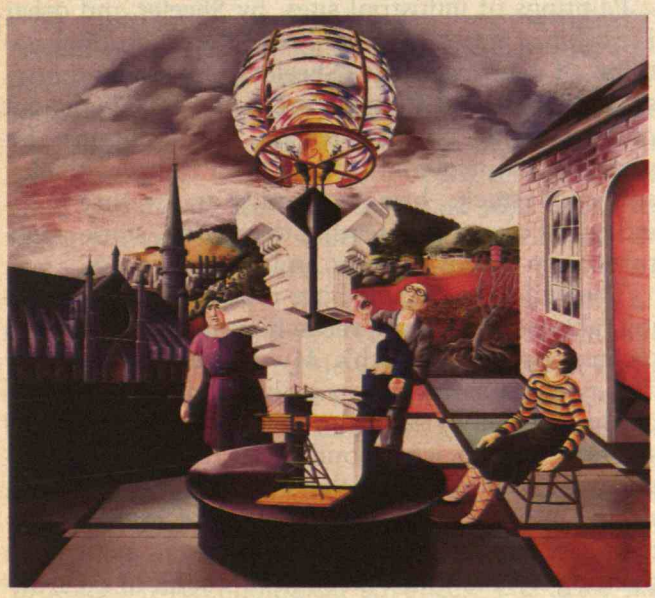

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a
Antoine Pevsner
Torso. 1924-26
Construction in plastic and copper 29½ × 11⅝″
Collection, The Museum of Modern Art, New York

b
Charles Demuth
My Egypt. 1927
Oil on composition board
35¾ x 30″
Collection, Whitney Museum of American Art, New York

c
Ernest Trova
Study: Falling Man Series Six Figures. 1964
Chrome-plated bronze, 16 x 19 x 19″
Collection, Whitney Museum of American Art, New York
Larry Aldrich Foundation Fund

d
Peter Blume
Light of the World. 1932
Oil on composition board
18 x 20¼″
Collection, Whitney Museum of American Art, New York

e
Cesar Baldaccini
The Yellow Buick. 1961
Compressed automobile
59½ x 30¾ x 24⅞″
Collection, The Museum of Modern Art, New York

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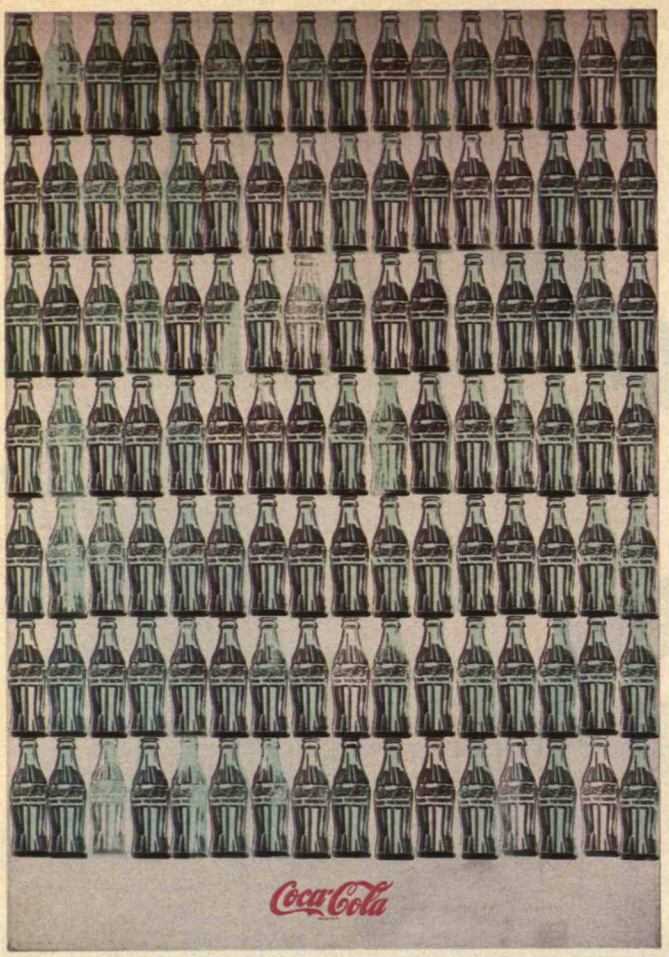

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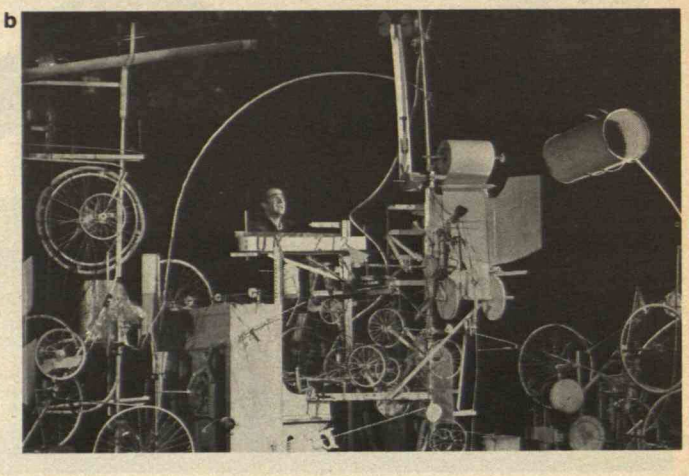

a
Andy Warhol
Green Coca-Cola Bottles. 1962
Oil on canvas, 82¼ x 57″
Collection, Whitney Museum of American Art
Gift of the Friends of the Whitney Museum of American Art

b
Jean Tinguely
Homage to New York
Photographer, David Gahr

c
Robert Breer
Osaka I
Self-propelled sculpture with fiberglass shell, steel frame, battery-driven motor, and rubber-tire wheels
6′ 1″ high x 6′ 1⅛″ diameter
Collection, The Museum of Modern Art, New York

d
Wen-Ying Tsai
Double Level Diffraction. 1973

Paintings of industrial sites, by Sheeler and other Precisionist painters, abandoned the traditional notions of landscape art. Sheeler's *American Landscape* (1930) and *Classic Landscape* (1931) do not portray gentle country terrain or mountains. Instead, he painted coal storage bins, railroad tracks, and smokestacks, bringing dignity and stature to his industrial scenes by creating the strong, stark structures from bright sunlight and deep shadows.

The buildings became huge monuments symbolizing, almost religiously, the achievements of modern technology. In Demuth's *My Egypt* (1927) (*page 70*), two grain elevators are the modern equivalent of the ancient pyramids — those massive cultural symbols of a society proud of its technological expertise. Similarly, Sheeler's *Incantation* (1946) makes industrial structures look like towering totems. In contrast, Peter Blume uses a meticulous painting style to mock machine worship. In the ironical *Light of the World* (1932), he suggests that traditional religious worship — represented by a church in the painting's background — has been supplanted by adulation for a dazzling new religious object: the electric light (*see page 71*).

During the 1940s and 1950s, American artists showed a mixture of amusement and alarm at the waste produced by modern industrialized society

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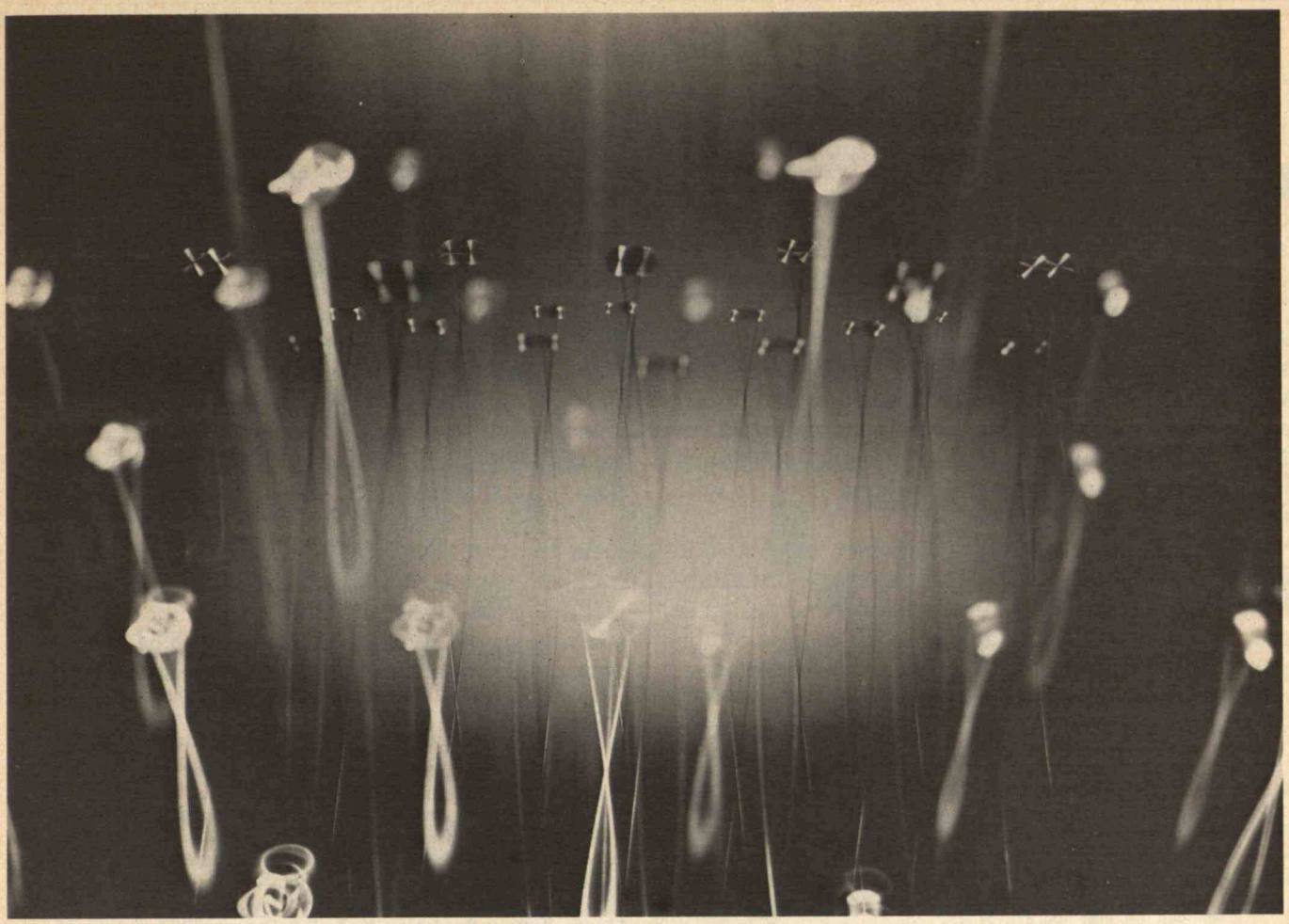

with "junk art" or "gutter art" — assemblages created out of scrap metal, assorted mechanical parts, and "found objects" such as beer cans and workers' tools. Cesar's sculpture *Yellow Buick* (1961) (*page 71*), spoofing the ephemeral nature of automobiles and America's "auto fixation," consists solely of a compressed car. Robert Rosenquist also expresses anxiety over society's perceived dependence on technology in his three-part painting *I Love You with My Ford* (1961). He mocks America's love affair with the automobile with a pair of automobile headlights, an enlarged view of kissing lovers, and a third section of intestine-like, enlarged spaghetti — the irony being that one can both love and die in the same place.

Ernest Trova's polished metal people — without arms or facial features — are anonymous reminders of the depersonalized, mechanistic personalities produced by technological advances. The acute nature of our dependence, the artist suggests, has made us armless — unable or unwilling to fend for ourselves (*see page 71*).

Jean Tinguely's satirical *Homage to New York,* subtitled *Self-Constructing, Self-Destroying Work of Art*, was built, displayed, and destroyed in the courtyard of New York's Museum of Modern Art on March 17, 1960. Fifteen motors sent soft-drink bottles crashing while music played, typewriters typed, and the machine produced its own drawings. In a dramatic finale, the machine set itself on fire (with some aid from the artist) in a last sardonic commentary on the lethal quality of modern technology (*see page 72*).

Rather than focusing on the destructive qualities of machines, other modern artists — particularly those associated with pop art — saw the benign aspects of America's technological society.

Andy Warhol's flat, detached, unemotional paintings of Coke bottles (*page 72*) and Campbell's soup cans, and Claes Oldenburg's gigantic "soft sculptures" of toasters, toilets, and typewriters, became the archetypes of pop art during the 1960s. Warhol, who at one time was said to have declared "I am a machine," embraced mass-produced objects as appropriate subjects of art. Taken out of context — away from the grocery shelf, home, or office — these common, manufactured objects could be viewed as sculptures in their own right.

Artists and Engineers

The 1960s also witnessed a more direct and positive engagement of artists with technology. Moving in an entirely new direction, they began using technologi-

cal resources such as plastics, lasers, and computers, and began seeking out scientists and engineers for collaboration. As art critic Barbara Rose noted, "Benefits to both artists and engineers have been inestimable. Through consulting with engineers and scientists, artists have been able to realize works that would otherwise have been impossible. Engineers and scientists . . . have learned how artists think. . . . Many have spoken of how their attitudes and values have been changed through firsthand contact with the [artist's] creative process."

A major project of Experiments in Art and Technology — an information clearinghouse established in 1966 — was the construction and design of the Pepsi-Cola Pavilion at Expo '70 in Osaka, Japan. The pavilion, which included the works of artists, engineers, and industries, displayed projects such as a 90-foot spherical mirror (the largest ever made), a fog that surrounded the pavilion and responded to changing atmospheric conditions, and a 36-foot sculpture that followed the sun's path and cast a 10-foot beam of sunlight into the fog with the aid of two mirrors. Robert Breer displayed his motorized sculptures *Osaka I* — 6-foot-high white domes that moved at 11 inches per minute and mysteriously reversed their direction when touched (*see page 72*).

One of the largest cooperative art and technology projects during the 1960s and 1970s has been the Los Angeles County Museum's Program in Art and Technology. Under this program, 23 artists have spent at least a year in residence at many major California industries including I.B.M., Lockheed, Philco, Ford, and Litton. Robert Whitman built a 23-foot semicircular wall holding 1,000 corner-shaped mirrors. From wherever the viewer stood, his/her reflection was repeated 1,000 times. Working with engineers from Teledyne Corp., Robert Rauschenberg constructed *Mud-Muse*, a 9-by-12-foot tank filled with mud that "erupted" into moving bubbles in response to sound waves.

These projects represent a growing interest among artists and engineers in creating works that are sensitive to the environment, e.g., to touch or sound. Called "feedback" or viewer-responsive sculptures, these works often seem to be alive. *Double Level Diffraction*, designed by Wen-Ying Tsai (an engineer turned sculptor), consists of electronically controlled strobe lights and stainless steel rods mounted on a platform. In response to sounds and the physical proximity of spectators, the sculpture's lights flash and its rods vibrate in asymmetrical patterns (*see page 73*).

Working with engineers from Philips Electronics in Holland, artist Edward Ihnatowicz created a sculpture in 1971 called *The Senster* — an 8-by-15-foot electronic dinosaur. The creature's head has microphones to "hear sounds and a radar device to track spectators' movements. Its digital computer "brain" tells the creature's systems how to respond. In response to moderate noise, its head moves with quiet motion, but if viewers shout, *Senster*'s head shies away.

Artists and engineers working cooperatively thus seem to accept technology while also transforming it. They create works of art that capitalize on technological skills and make machines more responsive to the human environment. The result is a pleasurable involvement of people with machines.

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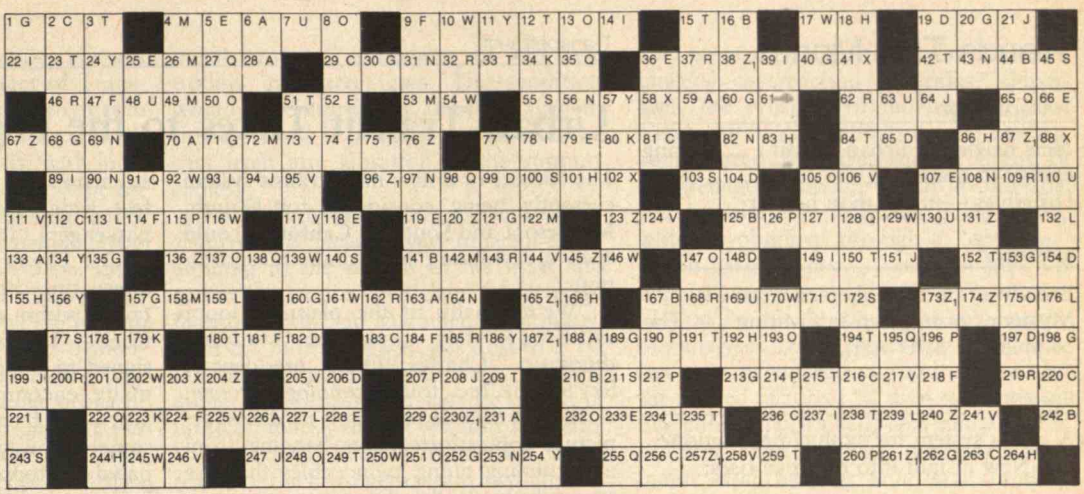
Julie Wosk is an assistant professor of art and English at the State University of New York Maritime College (Bronx) — a college specializing in engineering, science, and marine transportation. She received graduate degrees in English from Harvard University and the University of Wisconsin, and has studied art at the Chicago Art Institute and Parsons School of Design. Dr. Wosk is a painter and graphics artist, a writer on industrial design and architecture, and a former managing editor of *Contemporary Literature*. She is actively involved in developing art and technology materials for people with technical backgrounds.

Breaking the Ice



Complete the word definitions; then enter the appropriate letters in the diagram to complete a quotation from an article on technology. The first letters of the defined words give the author and title from which the quotation is taken. Black squares in the diagram indicate the ends of words; if there is no black square at the right end of the diagram, the word continues on the next line.

A solution to this Tech-Crostic will be given in the next issue of the Review, when another of Mr. Forsberg's puzzles will also appear. Readers are invited to comment — and to suggest favorite texts for future puzzles.

A. Danish philologist, 1860-1943
6 226 70 188 163 133 231 59 28

B. Unconventional (colloq. comp.)
210 167 16 242 44 125 141

C. Ballad opera by Ralph Vaughn Williams, 1924
229 183 216 220 236 2 171 251 81
256 29 112 263

D. Speleological phenomenon in Utah (2 wds.)
148 154 85 206 104 197 19 99 182

E. Character in Lewis Carroll's "A Tangled Tale" (2 wds.)
36 66 79 119 5 228 25 233 52
107 118

F. King of Egypt, 1375-1358 B.C.
74 114 181 9 184 47 218 196 224

G. One of the founders of written language (Kipling, "Just So Stories") (Full name)
157 68 60 153 71 135 262 252 1
30 213 20 40 121 198 189 160

H. Popular symphonic conductor from E. Germany
244 155 18 101 166 83 192 264 86

I. Vituperation
39 78 89 221 22 14 149 127 237

J. Unit of university instruction
94 151 247 208 199 21 64

K. Ore deposit
34 223 179 80

L. Design of a font of printed letters (comp.)
239 176 227 234 132 113 93 159

M. Order of deep-sea spiny eels
158 49 53 122 72 142 4 26

N. Expatriate Argentine poet, 1805-1851
90 108 31 56 43 97 164 69 82
253

O. Formula for necromantic conjuration
105 201 50 248 13 175 193 137 232
8 147

P. Held sway
190 115 207 260 212 214 126

Q. Feature of American steam locomotives
255 27 65 222 128 138 195 91 35
98

R. Four (3 wds.)
62 143 37 219 32 200 109 185 162
46 168

S. 1350-mile river through Burma
100 45 140 103 211 177 55 172 243

T. Professor Twist (Ogden Nash, "The Purist") (2 wds.)
33 42 249 61 75 215 3 178 259
84 15 23 209 152 150 51 12 235
180 194 238 191

U. Dutch composer, 1430-1505
7 110 169 246 130 63 48

V. Solid bounded by twenty polygons
117 225 124 258 144 217 95 241 111
205 106

W. Writer and journalist in America and Japan, 1850-1904 (full name)
202 250 10 170 17 146 92 54 245
139 161 116 129

X. Italian mathematician noted for his Poles
58 88 41 102 203

Y. Meeting expectation (Colloq. 3 wds.)
77 57 156 134 24 254 186 73 11

Z. Town in central Texas
204 136 76 240 123 174 120 67 131
145

Z_1. Arizona Indian tribe
87 257 38 173 96 261 187 230 165

Trend of Affairs

Trends This Month

Transportation

Urban Transit Takes to the High Wire

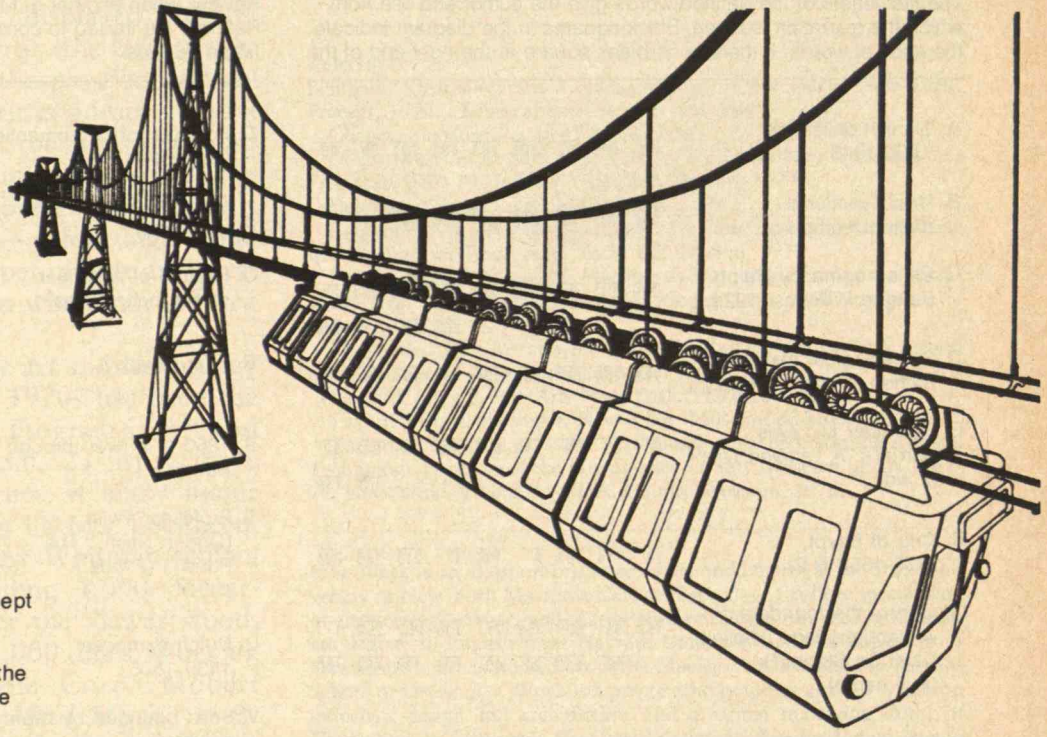
The success of a new mass transit system currently being considered for Duluth, Minnesota and Southern California could spell a revolution for urban transportation.

"We're finally in the planning loop; until now they have been studying dinosaurs," Charles Willetts, president of Sky Shuttle, Inc., told *Technology Review*.

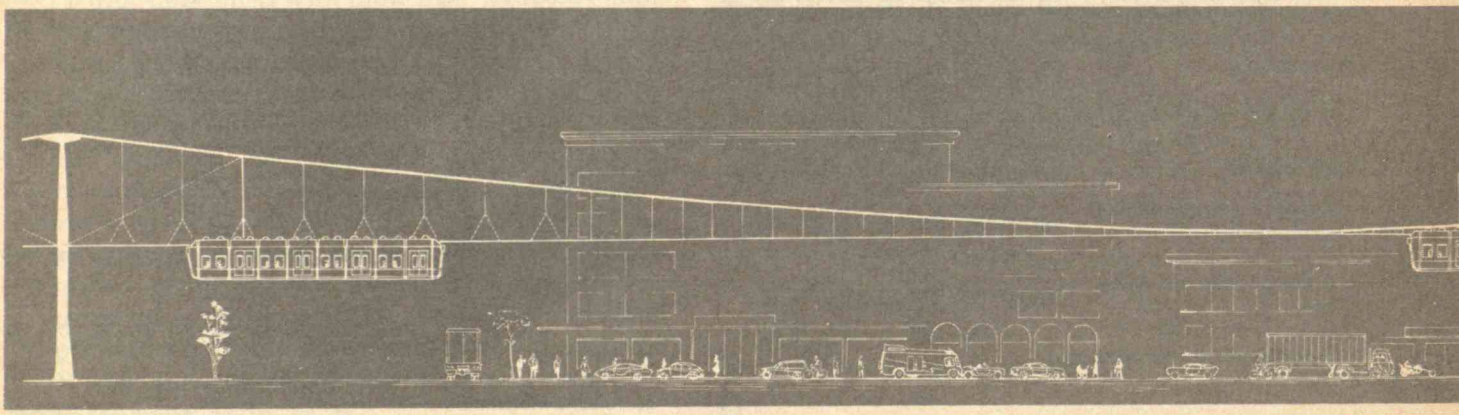
The Sky Shuttle concept is no dinosaur: picture sophisticated cars hanging from and running along twin cables that are strung from slender support towers.

The lightweight aerodynamic gondolas will be made largely of advanced composite materials, will be 70 feet long by 10 feet wide, and will accommodate 156 passengers, including those in wheelchairs. Power will come from 18-pole, alternating-current motors neatly contained within each of the 32 rubber-tired wheels. The wheel hub motors are designed to minimize frictional losses normally encountered with bearings and gears, to recover through regeneration some of the kinetic energy usually dissipated in stopping a vehicle by frictional braking, and to save weight.

According to Mr. Willetts' projections, Sky Shuttle's low construction and operat-



The cars aren't upside down. This concept in urban transport has electrified cars hanging from twin-cable guideways. Suspension bridge technology permits the support towers to be spaced eight to the mile. *(Drawings: Sky Shuttle, Inc.)*



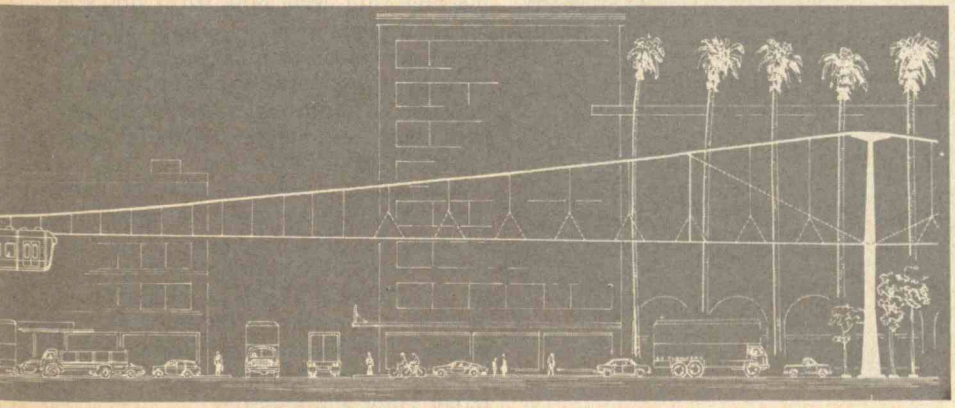
ing costs are strong selling points. He says the system fits the Department of Transportation's capital grants program criteria. That program could pay for 80 per cent of construction costs, with local or private funds covering the rest. Operating costs early on the learning curve would be about $2.25 per car-mile; typical street cars cost up to $3.75 per mile. The guideway could be built for about $6 million per mile, based on the $10 million cost estimated for the 1.6-mile demonstration line proposed for Duluth. Compare recent costs for tunneling projects: Atlanta recently spent $85 million per mile; Washington, D.C., about $100 million per mile; and Los Angeles, $66 million per mile. And tunneling is precluded in some cities because of geologic factors, such as in New Orleans and Miami where the water table is too high.

Construction time and land-use requirements are comparatively modest. According to Mr. Willetts, Sky Shuttle would take only one-fourth to one-fifth the time to erect than do other fixed guideway or rail systems. Only eight slender "T"-towers are needed to support one mile of guideway, similar to a suspension bridge. Contrast the typical elevated train system's sturdy steel columns placed every 75 feet and supporting a massive concrete and steel track bed 10 feet wide by 7 feet deep. Says Mr. Willetts: "These conventional supporting structures and guideways take away considerable premium surface in metropolitan areas, cause extensive shadowing and snow collection problems, and are seismically questionable." Indeed, among Sky Shuttle's attributes, he is quick to add, is "superior earthquake tolerance."

This transportation concept certainly captures the imagination: one could glide noiselessly above city streets in a vehicle that rides and feels like an airliner rather than a (gasp) subway car, silently slowing, stopping, and accelerating, free of the metal-on-metal screeching of old-style trolleys and street cars. The sensation would be reinforced by an oil-air suspension system (à la Citroën) that isolates the cars from any vibration in the support cables.

Mr. Willetts says from experience, "It's a universally pleasing way to see a city," alluding to the success of the first- and second-generation lines that ran for eight months in 1975 in Mannheim, Germany. That 2.2-mile guideway was host to 2 1/2 million passengers who were whisked along in 100-passenger cars at speeds of up to 50 miles per hour without incident.

Are transit-hungry American cities ready for the third-generation Sky Shuttle? Mr. Willetts promises: "We can do a lot with less real estate." — *L.A.P.* □



Moving Energy in the Next Decade

Will U.S. transportation be up to the job of getting energy to market during the twilight years of the 20th century? President Carter has charged the Department of Transportation (D.O.T.) and the Department of Energy (D.O.E.) to find out jointly in their upcoming national energy transportation study (N.E.T.S.).

John E. Harman, acting deputy director of the D.O.T. Office of Intermodal Transportation, summarized the progress of his agency's findings during a seminar held this fall in Chicago by The Energy Bureau, Inc., a New York consulting firm.

□ *Coal by barge.* The use — and therefore the interregional transportation — of coal will double between 1975 and 1985 and again between 1985 and 1990. Coal mined in the West will be moved eastward. "Some isolated waterway bottlenecks in certain locks" are foreseen by the D.O.T. between Wyoming and Texas in 1990, but "the lock capacity will be there . . . given the [U.S. Army] Corps of Engineers' construction programs." However, the prospect of moving that coal from waterway terminals to end-users is complicated by "tremendous highway maintenance problems" that go unresolved because the Highway Trust Fund, which is obtained through a "cents-per-gallon gasoline tax . . . has not kept up with inflation."

□ *Coal by rail.* In contrast to some previous analyses, D.O.T. finds that it will take less time to enlarge railroad capacity by the needed factor of 12 than to "bring on line either the [needed] coal mines or the utilities." The railroads concerned with major coal hauling will have funding available from either internal funds or private capital markets." But coal trains will cause serious environmental and social impacts, and the D.O.T. is studying their likely effects on small Western communities (*see "Coal: The Ace-in-the-Hole That Isn't There," Mar./Apr., 1979, p. 68*). Two major problems promise to challenge efforts at a solution: "A lot of [the negative effects of] coal unit trains will occur in states that are not actually [coal] producers," and in many cases "the [financial] resources simply aren't there" for dealing with the problems.

□ *Coal slurry pipelines.* "The numbers don't seem to indicate the need" for pipelines before 1985, and there are two major roadblocks to construction beyond that point: the thorny issue of eminent domain and limited water availability.

□ *Crude oil.* An apparent paradox looms: "By 1990, if we import less oil, we actually will transport more oil, because we have to get more from Alaska and relatively remote sources in the U.S." If new refineries are built closer to areas of consumption, interregional transportation of petroleum products will decline. But this is a big "if," and "there are a lot of glitches that could develop."

For example, the current surplus of Alaskan crude oil on the West Coast and plans for a new west-to-east crude oil pipeline would seem to spell relief for crude-short "northern tier states" such as Montana. Unfortunately, the surplus is expected to disappear by 1990, and anyway Alaskan crude is incompatible with most of the northern tier refineries. Nevertheless, a pipeline could be used to move Alaskan oil to appropriately geared Midwest refineries and at the same time bring imported oil to the northern tier states from West Coast ports.

□ *Gas.* Few physical constraints exist in the movement of natural gas from Mexico, liquefied natural gas (LNG), or

liquefied petroleum gas (LPG). "We can transport a lot more natural gas from Mexico by feeding it into the present [pipeline] network coming out of Texas than we are presently committed to get from Mexico." A "more intractable issue" is the safe transport of LNG and LPG. There have been no fatalities associated with LNG shipping since 1944 (*see "LNG Safety: A Matter of Scale," Feb., 1978, p. 56*), but LPG has had "a lot more problems," particularly during rail shipping. And a retrofit program on LPG railcars to provide more safety hasn't solved the problem.

☐ *Nuclear.* The transportation outlook is bleak. "Restrictive state and local regulations" have placed a growing load on the temporary storage facilities of many nuclear power plants. "There are . . . forty-some places where state and local governments have in effect cut out the movement of nuclear spent fuels and wastes."

Regulatory uncertainties at the federal level have added to the problems of shippers of nuclear waste. For example, the Nuclear Regulatory Commission (N.R.C.) officially bans the movement of spent fuel through urbanized areas with populations greater than 100,000, but ". . . has allowed special dispensation for all requests [from nuclear shippers] so far."

The D.O.T., in contrast, clearly preempts state and local regulation of the routes over which spent nuclear fuel and wastes can be transported, but allows states to set the time of day when such movements can occur.

Is the regulatory firmness of state and local governments and federal agencies such as the D.O.T. categorically preferable to the pragmatic flexibility of, say, the N.R.C.? We must decide which policies best serve our nation before the new energy shipments begin. And time is growing short. — *L.A.P.* ☐

Repeated Rebirths of the Dirigible

Much is right — and nothing very wrong — with the commercial prospects of lighter-than-air craft . . . except that none has been built in the last 40 years.

Among advocates there is unbounded optimism; moving lumber and large industrial machines, surveying traffic, and all manner of human and environmental activities are popular objectives. Consider Serge Antoine, head of the Research and Development Mission of the French Ministry of the Environment, for example: It is time to stop singing the praises of the airship and start marching, he told his fellow-enthusiasts at the second symposium on the Economics and Technology of Modern Airships near Paris early this year.

Two would-be marchers were reported awaiting their orders:

☐ *The Helicostat AZ-100* is a hybrid — two helicopter rotors and a 3,000-cubic-meter nonrigid balloon — designed to lift up to four tons of timber from otherwise inaccessible mountainous areas in France. Roger Gau of Société Nationale Industrielle Aérospatial, Paris, put the cost per ton at less than that of a helicopter. (A larger version of the same concept is proposed by Kawasaki Heavy Industries in Japan for unloading containerships in 30-ton increments.)

☐ *Dinosaur* is a remote-controlled nonrigid balloon which could carry 250 kilograms to an altitude of 3,000 meters. It's proposed by the Etablissement d'Etudes et de Recherches Météorologiques, Paris, as a poor man's atmospheric probe for studies in cloud physics and air pollution.

From the visionaries in the business came some far-out proposals:

☐ *Sunship* is a solar-powered airship conceived by Professor M. Gabriel Khoury of Imperial College of Science and Technology, London. With solar cells weighing in at 0.6 kilograms per square meter, *Sunship* would have to be large — a minimum of 50-ton payload. It would need nine hours of sunshine to operate for a 24-hour day, limiting its use to between 10° and 30° latitude.

☐ *Thermoskyship* would ferry passengers across the English Channel in competition with ferries, hydrofoils, and hovercraft. With a 45-meter-diameter circular platform, it would carry a minimum of six tons, but the real payoff would come from a 100-ton version. Malcolm Wren, managing director of Thermoskyships, Ltd., Isle of Man, put development cost at $22 million.

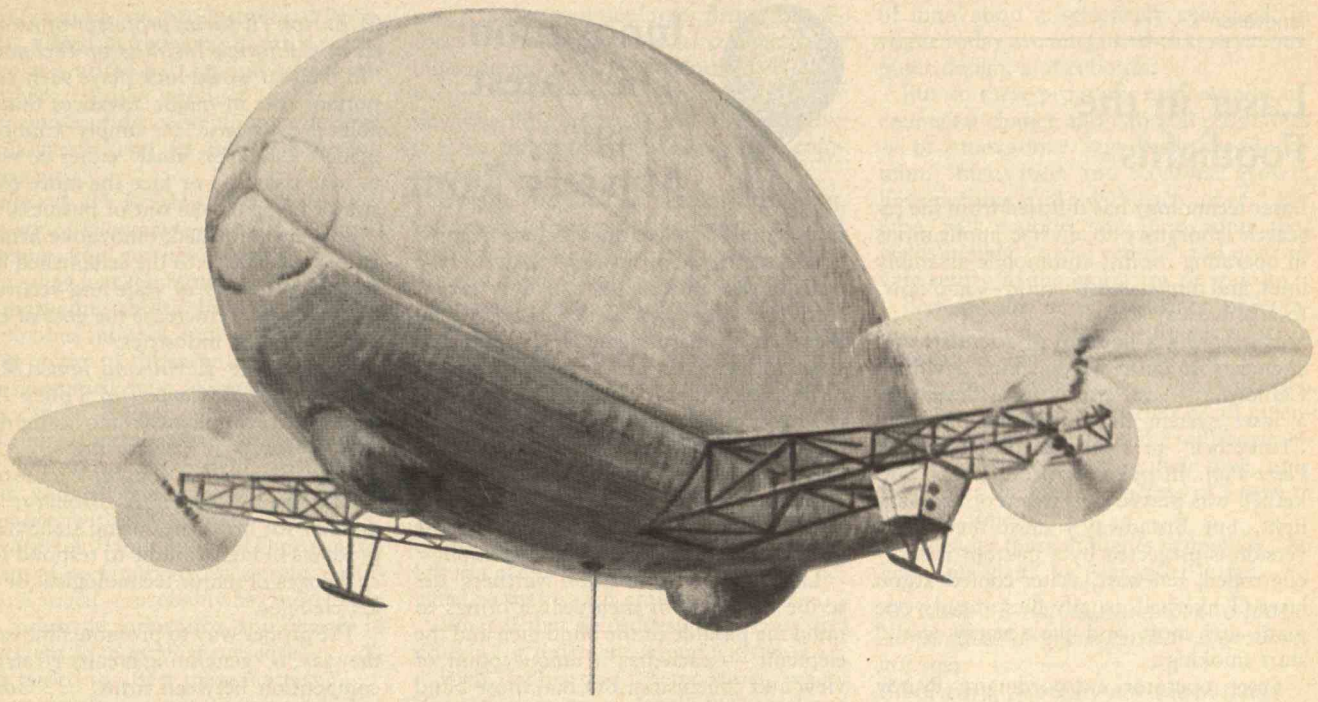
But even these projects now on paper fall far short of the size which seems viable to most advocates. Japanese attending the meeting said that 500- to 1,000-ton lighter-than-air vehicles — and perhaps very small ones — can be profitable, but they were pessimistic about anything in between. A German engineer put the size even higher — volumes of 600,000 cubic meters at a minimum.

A Brazilian delegation came to Paris with $300,000 to invest in feasibility studies for a lighter-than-air vehicle that would carry 300 tons of heavy cargo over the impenetrable jungles of their nation's northwest. Similar interests were expressed by Alberta Transportation of Canada and the Japanese Ministry of Internal Trade and Industry.

U.S. Energy Use
(Quadrillion B.t.u.s)

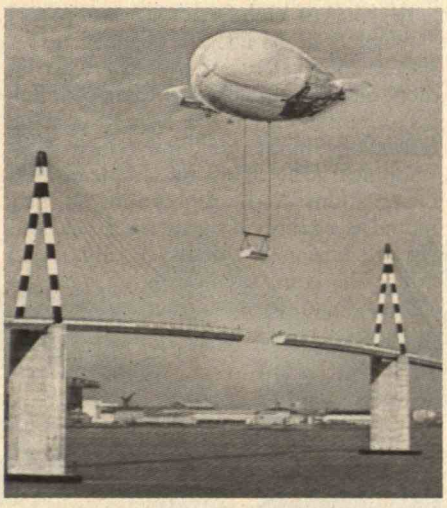
	1975	1985	1990			1995
			Low oil	Medium oil	High oil	Medium oil
Coal	13.4	20.8	26.6	29.1	31.6	39.4
Oil	30.2	39.2	46.4	40.0	33.6	40.3
Gas	22.9	20.1	18.8	19.4	19.2	18.7
Nuclear	1.9	6.6	9.5	9.4	9.5	12.7
Other	3.4	3.2	3.5	3.5	3.5	4.0
Totals	71.8	89.9	104.8	101.5	97.3	115.0

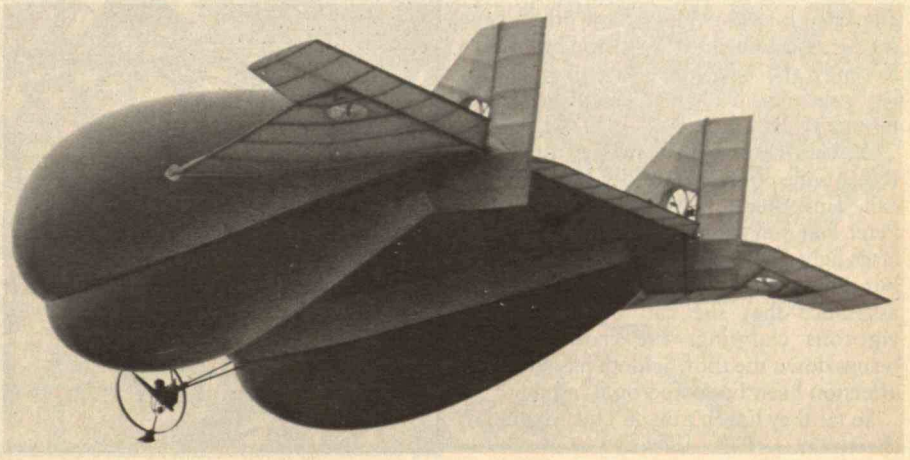
An estimate of U.S. energy demand to the year 1995. Note the effect of high and low world oil prices on other fuels. *(Data: U.S. Energy Information Administration)*



But the shadow of the *Hindenberg* still hangs over lighter-than-air technology, and institutional problems may be the most stubborn roadblocks. New technology — light-weight materials and new bonding systems — is ready. But a whole new system of studies is needed, including the mechanics, aerodynamics, and aerothermics (gas in large envelopes) of the airship, said Jacques Bouttes, director for aerospace applications of the French Office National d'Études et de Recherches Aérospatiales.

Such an effort will take at least ten years of research without any return on investment. Only a government (or a consortium of them) could underwrite such a program; and Captain P. F. Gibber, U.S.N., commanding officer of the London Office of the U.S. Office of Naval Research, whose account of the conference in *European Scientific Notes* (33:7) this report paraphrases, is pessimistic: the next airship symposium is likely still to be proclaiming *la renaissance du dirigeable.* — *J.M.* □





Above and left: *Helicostat AZ-100,* a proposed helicopter/dirigible hybrid. *(Drawing: Société Nationale Industrielle Aérospatial)*
Below: Prototype of *Dinosaur,* during a flight test. This is not a large airship, despite its name, and is designed for payloads of only about 550 pounds. *(Photo: Etablissement d'Études et Recherches Météorologiques)*

Innovation

Laser in the Footlights

Laser technology has diffused from the research laboratory to diverse applications in operating rooms, automobile assembly lines, and tunnel construction — and now, to a Broadway show.

Last spring a handful of scientists and engineers at Laser Media, Inc., a with-it California special-effects firm, developed a laser system that recreates the fairy "Tinkerbell" in a musical production of *Peter Pan*. In previous productions Tinkerbell was played by a beam of ordinary light, but Broadway's up-to-the-minute version is projected by a microprocessor-controlled, ten-watt, water-cooled argon laser (Tinkerbell usually flies at only one watt; any more and the scenery would start smoking).

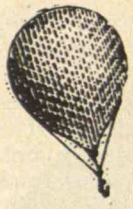
Laser operator extraordinaire Randy Johnson brings Tinkerbell to life for each night's show at the Lunt-Fontanne Theatre in New York from front row, balcony. Randy constantly adjusts a repertoire of 15 flight patterns and other actions so that Tinkerbell can interact better with the human actors in the musical.

Six light frequencies, three in the upper blue-green and three in the ultraviolet range, are combined to give the projected image an ethereal, fluorescent green color. The laser beam is 1 millimeter in diameter as it leaves the oscillator; by the time it reaches the stage 100 feet away, it's about the size of a 50-cent piece.

The laser scans a butterfly shape several hundred times per second in slightly different patterns to create the fluttering fairy. Tinkerbell is made to grow or shrink, to "write," and to "speak," with the help of a more conventional special-effect — a celeste. Like any other performer, Tinkerbell has good and bad days. Recently she had a pressure problem in her ionizing tube, "but I've got her fixed up now," said Randy.

Audience reaction is strong and positive. At one point in the story, you may recall, Tinkerbell takes poison intended for Peter Pan and succumbs. In the show the laser light grows increasingly dim and all but disappears. In response to Peter Pan's assurance that she can be revived by vigorous clapping, the crowd nearly brings down the roof. Seldom has so much affection been bestowed on a laser.

So far they haven't made Tinkerbell join the union. — *K.R.* □



Innovation: The Latest Magical Mystery Tour

Innovation — where does it come from? If you can't think of an easy answer, take heart. Even aficionados can only recant fortuitous blendings of intellect, environment, and some undefinable catalyst that seem to have served as midwives to the birth of new ideas.

Truly qualitative breakthroughs of theory, process, or equipment are far more mysterious than the incremental changes that, like snow on a rooftop, inevitably settle on and partly obscure the genius behind an established invention.

Listening to innovation-watchers describe the fruits of their search brings to mind the parable of the blind men and the elephant — each has a unique point of view and conclusion. But had those blind men all been sculptors. . . .

A group of such latter-day "sculptors" assembled at M.I.T. in October in response to a call from J. Herbert Hollomon, director of the M.I.T. Center for Policy Alternatives, for a symposium on technology, innovation, and industrial development. The following sample of their observations and admonitions is presented as a gallery showing for the curious visitor. The astute observer cannot but notice the common threads of some insights — and the divergence of others.

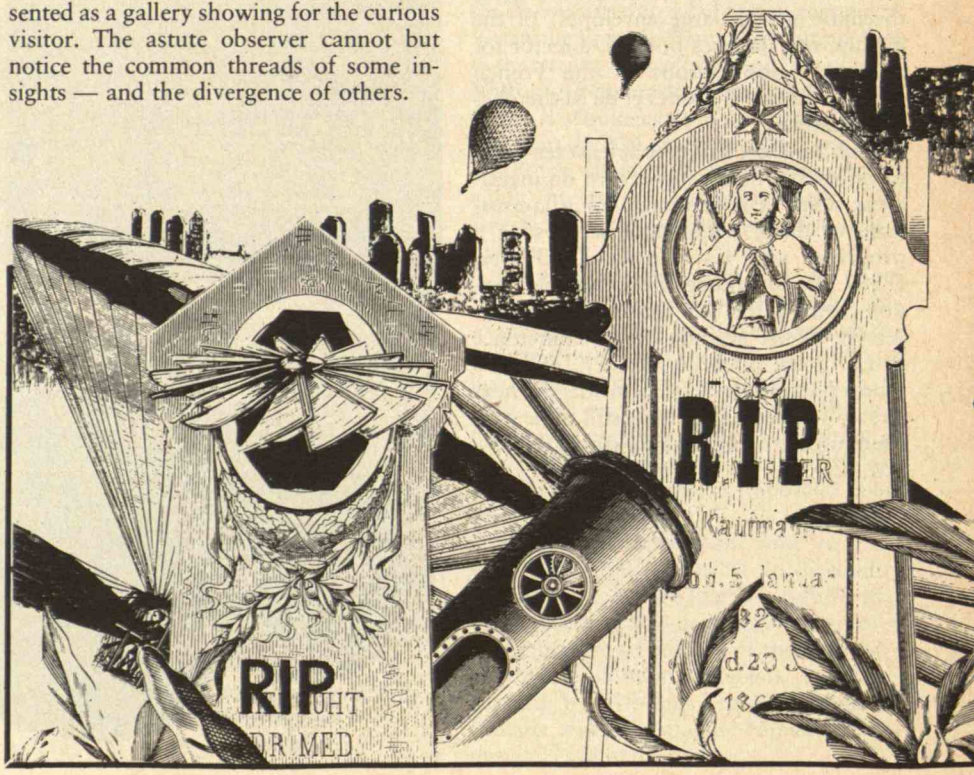
□ *Burton H. Klein, professor of economics at California Institute of Technology*: "In the real world luck plays such an important role in major advances that reliable predictions . . . simply cannot be made." U.S. firms must "either be willing to take risks . . . or face the more certain risk of being driven out of business."

But newly formed, innovative firms are at a disadvantage to the established firms, whose "economy of scale and vertical integration act to increase the cost of entering established industries."

□ *Christopher T. Hill and James M. Utterback, M.I.T. Center for Policy Alternatives*: "Technological innovation nearly always occurs in private firms. . . . The greater the advance sought, the more uncertain the outcome." A corollary: "It is difficult for firms producing standardized products in high volume to respond to the challenges of major technological or market changes."

The proper way to promote innovation, they say, is "generating greater rivalry and competition between firms. . . . Government should take steps to encourage innovation by increasing the risks that firms face — not by increasing the risk of failure of new technology but by increasing the risk that a firm will fail if it does not innovate!"

And big news: regulation does not hin-



der innovation or productivity. "Regulations aimed at reducing hazards in the workplace, in the natural and human environment, and in product use are not major causes of the contemporary declines in innovation and in productivity improvements."

□ *Edward B. Roberts, David Sarnoff professor of management at M.I.T.*: Small companies can get new ideas *to* market but not *into* market; large companies have that marketing ability, but not the ideas. The obvious move is somehow to join the strong points of the large and small firm "into combined, mutual interests, which I think can be accomplished through joint venturing rather than through acquisition. . . . That route can benefit small companies with sustained growth and large companies with new product flow. . . ."

□ *Professor Hollomon*: "The general climate of a country — economic, political, and social — probably has more to do with industrial innovation and change in investment than explicit measures . . . directly aimed to affect these matters."

For example, innovation sometimes has "nothing whatsoever to do with research and development; . . . [R & D] sometimes involves new and small firms as entrepreneurs, and sometimes larger firms." However, "it is not possible to connect how much money a country spends for R & D to the general end which says how innovative the country is and how effective it is in translating new ideas into commercial practice."

Despite the lack of clearcut causality, success by association has prompted "all countries of the world except the U.S. to directly support some part of the development of new products and processes." For example, a 1969 West German law in support of such development was based on the conviction that "the future security and welfare of the German nation depended as much on the health and welfare of its economy and its industry as it did on any military might." Stirring words, to be sure, but note that the applicants for that support must meet "the criteria of the field in which they have decided to make such an investment."

What if that field doesn't yet exist and criteria for judgment are nonexistent?

Such doubts don't deter Israel, where "any firm large or small may make a proposal to the government to subsidize," and "independent of field, independent of industry, the government will provide from 50 to 80 per cent of those costs."

But "the best farmers farm two and three times as [much as] the least able farmers," so in Japan government support of innovation is selectively exercised. In vogue today are integrated circuitry, computer design, and robotics.

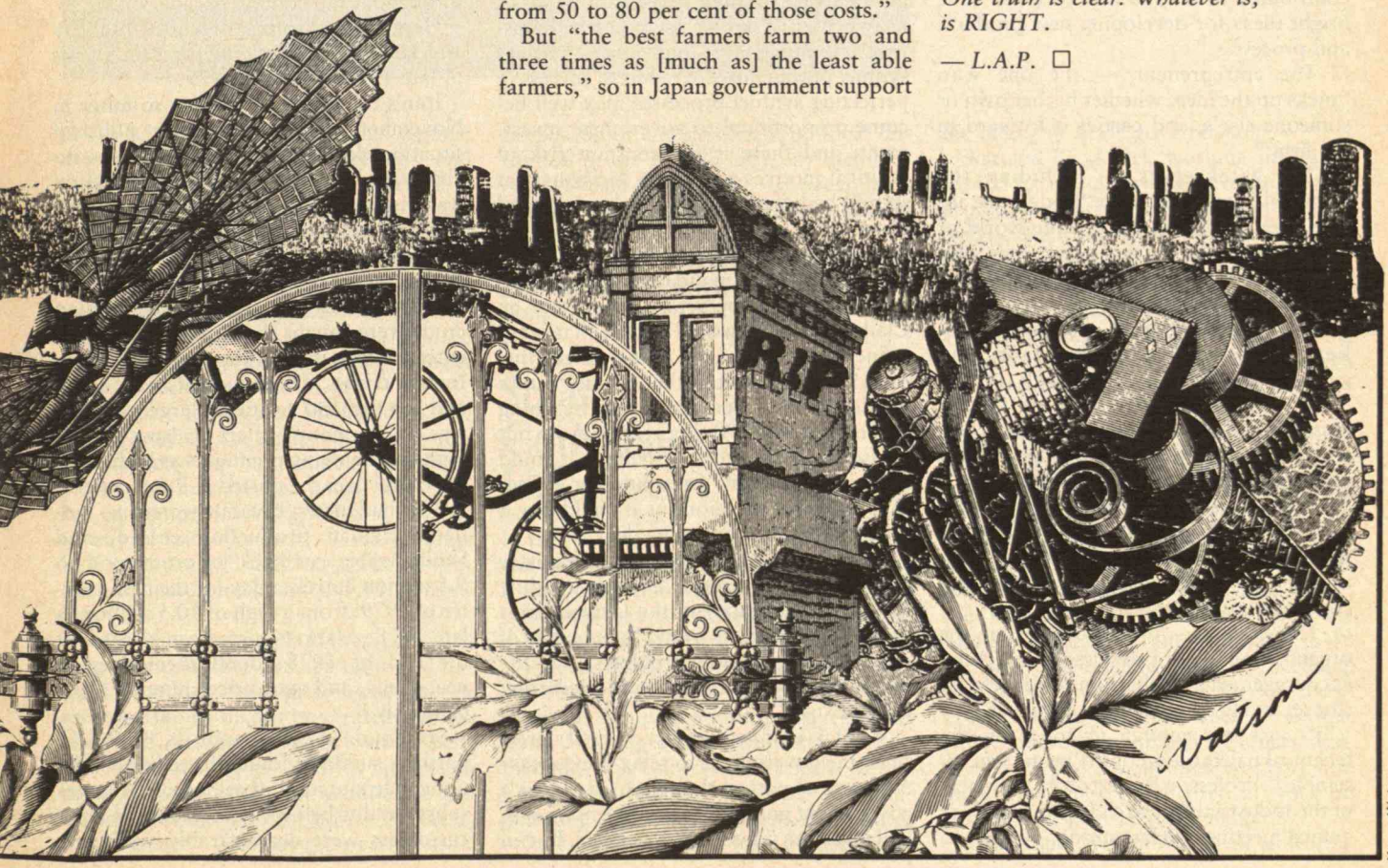
But do these programs help support incremental change and national economies — or innovation? Says Professor Hollomon, "Innovation and economic growth have nothing to do with each other." Yet who will support the innovation that yields mainly "social return" and not private return to the innovator or sponsor?

Perhaps the most important observation may be this: when the time is right, an innovation will fly; when the time is wrong, the graveyard of failures will open its gates. Perhaps the sorriest of all inventions buried there are the stillborn — those that arrived before their time, only to witness the jubilant success of a twin in another time.

Consider these thoughts penned in "An Essay on Man" by Alexander Pope:

All Nature is but art, unknown to thee;
All chance, direction, which thou canst not see;
All discord, harmony not understood;
All partial evil, universal good;
And, spite of pride, in erring reason's spite;
One truth is clear: Whatever is, is RIGHT.

— *L.A.P.* □



Karen Watson

Five Critical Functions in R & D

The team assembled by your technical director to perform research and development includes chemists, chemical engineers, a few marketing experts, process engineers, metallurgists and materials people, and an appropriate number of managers. But it doesn't seem to be working well: too few new ideas come from R & D into production and eventually influence the balance sheet.

Your problem may well be that you've neglected "critical function" staffing, says Edward B. Roberts, David Sarnoff professor of management at M.I.T.

After a decade of studying industrial research and development organizations, Professor Roberts concludes that "only 20 to 30 per cent of the people in a typical R & D laboratory provide what uniquely matters in achieving innovation." In addition to whatever professional disciplines are required, five functional positions must be filled in every R & D group if profitable innovation is actually to occur:

☐ The idea generator — the "creative contributor who comes up with the new, bright ideas for developing new products and processes."

☐ The entrepreneur — the one who "picks up the idea, whether his/her own or someone else's, and carries it forward in the firm."

☐ The gatekeepers — including the technical gatekeeper who "bridges the inside organization to the outside world of technology"; the market gatekeeper who "understands what the competition is doing, what the regulators are up to, and what is happening in the user marketplace"; and the manufacturing gatekeeper who knows enough of the "real, hard-nosed environment of the manufacturing plant to keep technical colleagues up to date on the realities of materials, processes, and labor skills."

☐ The program manager — the one who formally or informally provides "planning, coordination, supervision and integration, and sensitivity to the roles and contributions of others."

☐ The sponsor — the "godfather" in the organization who provides "protection, encouragement, facilitation, and help to (those) trying to push ideas forward."

It's just not enough to focus on the technical background of the teams you assemble," Professor Roberts told members of the Industrial Research Institute at their annual meeting late last spring. — *J.M.* ☐

Energy

Keep Government Out of Synfuels

Everyone agrees that to escape the grip of O.P.E.C. the United States needs to turn its plentiful coal and shale into oil and gas. But such synthetic fuels will be more expensive — at least for several decades — than the conventional fuels they replace. So the talk quickly turns to financial incentives to spur a synfuels industry: government loan guarantees and tax abatements to synfuel plant builders, government financing through equity ownership or low-interest loans, and government guarantees of the future price and/or market for synfuels.

Hoyt C. Hottel, professor emeritus of chemical engineering at M.I.T., doesn't like these ideas. They all involve bringing government into the management of an essential energy industry, he told the Senate Committee on Banking, Housing, and Urban Affairs late last summer. Risk is transferred from private industry, which has the technical skills, to the government, which doesn't; the extra costs of synfuels are financed through taxes paid by all of us, whether or not we use synfuels; industrial incentives for innovative, efficient synfuel production are reduced; success in perfecting synfuel processes may well become proportional to government investment; and there is the constant risk of political motives tarnishing decisions that should be based solely on technology and economics.

Professor Hottel appeared in Washington to support a "mandated" synfuel consumption plan put before the Senate by Claiborne Pell: it would require that every refiner use at least 1 per cent synthetic fuel by 1985. Thereafter the synfuel quota would rise by 2 per cent a year, reaching 10 per cent by 1990. If a refiner chose not to use meet the quota of synfuel, it could buy extra "points" from another refiner that exceeded its quota or it could pay a penalty proportional to its deficiency.

Professor Hottel believes that industry can meet these targets. Though building new synfuel capacity in the United States in the next five years would "not be free of unsolved engineering problems, ... the know-how for building and operating plants exists."

What if, despite that fact, industry pressures the government to relax the quotas? An essential part of the proposed plan is a government guarantee to compensate synfuel investors if quotas are reduced. But an even more important part of the plan was suggested by Professor Hottel when he told the committee, "The speed with which problems are solved depends on the punishment for not solving them." — *J.M.* ☐

The Oil Ratchet: Prices Up, Never Down

The world is not about to run out of oil. But world oil prices have only one way to go in the next decade — up, and probably sharply so. "Substantial price increases are likely by 1990 . . . 25 to 50 per cent in real dollars over current levels," according to a new prediction by members of the World Oil Project of the M.I.T. Center for Energy Policy Reseach.

Many analysts considered oil price rises of the magnitude that occurred last winter and spring possible, but few believed them likely. Members of the M.I.T. group now see those events as a preview of the future: they expect frequent, irreversible, and perhaps substantial oil price increases throughout the coming decade.

Here is how Professor Henry D. Jacoby and James L. Paddock interpret the events of late 1978 and early 1979:

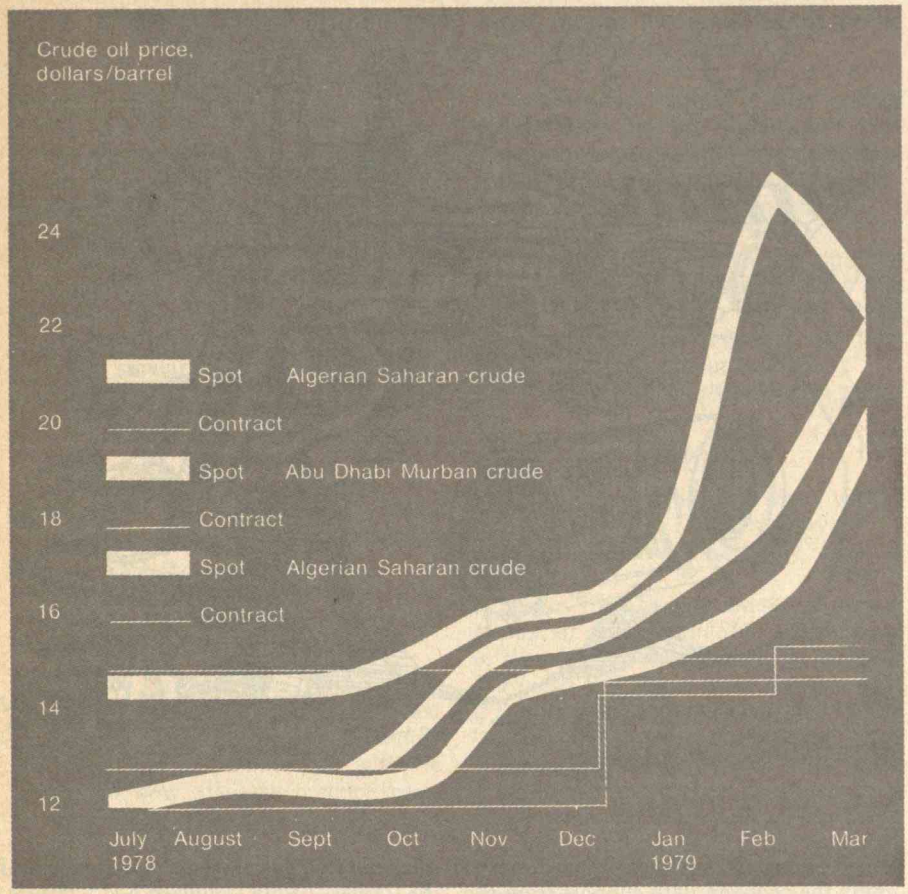
Iran's oil production began to falter in November as that country's political situation deteriorated. But there was no absolute shortage: world oil production was rising because of growing demand and perhaps because of stockpiling in anticipation of a modest O.P.E.C. price rise at the beginning of 1979.

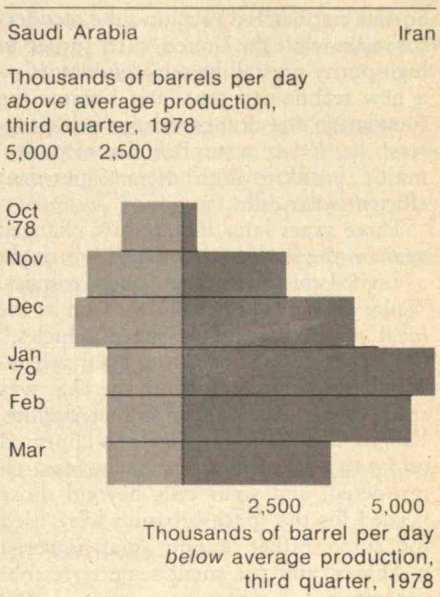
Users heavily dependent on Iranian crude were caught short, and they had to enter the spot market for equivalent, non-Iranian crudes. Those markets were small and the demand relatively large, so there was a "dramatic" effect on spot prices, with bids showing premiums as high as $4 per barrel over the posted O.P.E.C. prices.

The bad news became worse in January: Iranian production ceased, and Saudi Arabia cut back its production to 9.5 million barrels a day for the first quarter of 1979, from a high of 10.5 million in late 1978. Markets already in tension at the end of 1978 found themselves in near-panic, and spot prices jumped "precipitously."

So Saudi Arabia and its O.P.E.C. partners suddenly found themselves in the untenable situation of selling oil at prices substantially below those many of their customers were demonstrably willing to

The anatomy of a "ratchet," as sketched by members of the M.I.T. World Oil Project. When Iranian crude oil production faltered in the last quarter of 1978 (right), refiners were forced to enter the spot market to make up their deficits. There was no "crunch" — the world was not "running out of oil," but demand drove spot market prices up sharply (left). Then came the end of Iranian production and a new, lowered production ceiling imposed by Saudi Arabia, leading to "precipitous" spot-price increases. Contract prices inevitably followed the spot market.





pay. They launched a campaign against the oil industry for "profiteering" and "ugly exploitation," and as of April 1 Saudi Arabia reduced production to 8.5 million barrels a day. Soon enough the O.P.E.C. countries gained their objective: crude oil sold well above the official prices everywhere, beginning at $13.34 per barrel. And the stage was set for O.P.E.C. to raise its official prices to nominal market prices, which happened in July, 1979.

Professor Jacoby and Mr. Paddock call it "the ratchet": in a tense market, prices and capacity can be manipulated so that prices rise and never fall back. "The market disruption [of 1978-79] was not due to any physical 'crunch' — no absolute lack of capacity," they say, "but to production management by O.P.E.C. members."

Will it happen again? Almost surely, as long as the market remains tight and nations pay high spot prices whenever a shortage looms or can be created. A U.S. reserve of a few million barrels would help very little; as long as O.P.E.C. has excess capacity with which to manipulate the market and the political power to use it, the "ratchet" will be a powerful tool. Even without any significant political disruption in the Middle East, say members of the World Oil Project, "we are in for a difficult time on the price front whatever we do."

Energy prices promise to be "a grinding problem that is going to last a generation," they say. — *J.M.* □

Solar Conversion: U.S.-Soviet See-Saw

If the technology for economical direct conversion of sunlight to electrical energy is developed in the 1980s, it will probably happen in the United States. A decade ago the laurels might have gone to the U.S.S.R.

Indeed, history reveals "an interesting out-of-phase succession of ups and downs between the two countries in expectations, funding, and accomplishments" in this field, says Gary M. Scher of the M.I.T. Center for Materials Science and Engineering. His analysis shows that photovoltaic technology has been a creature at the mercy of fickle governments.

Antoine Becquerel, working in France in 1839, first described a reaction that produced electricity from light in an electrolytic solution, and 40 years later the same reaction was made to work in a solid, selenium, in Britain. But not until the 1920s when quantum mechanics provided a theory to explain what happened in the laboratory did understanding blossom into interest in solar cells as useful energy sources.

In the Soviet Union, early experimental work was so encouraging that Abram F. Ioffe, the founder of the Leningrad Physicotechnical Institute, told a gathering of scientists in Leningrad in 1931, "It is possible to surmise that the further development of photocells can lead to . . . the use of sunlight for energy." He foresaw efficiencies ranging from 8 to 10 per cent and recommended "proceeding with utmost perseverence in this direction." During the ten years thereafter, light-induced electromagnetic effects were discovered by Kikoin and Noskov, and there was important theoretical work on electric transport in semiconductors.

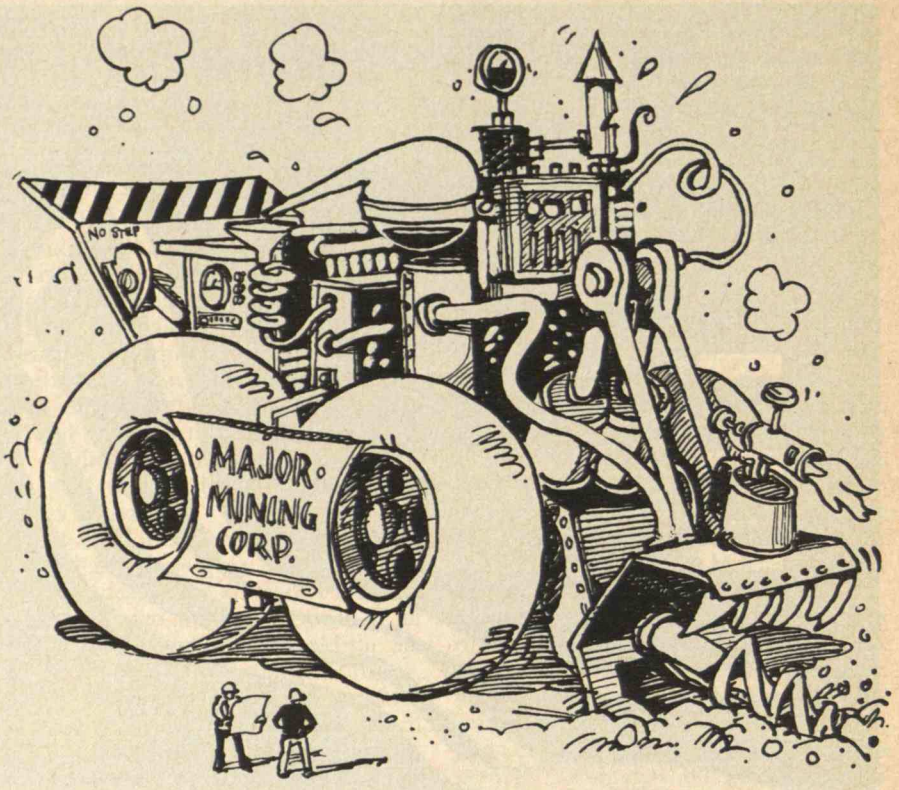
Then came World War II, in which the

Soviets emphasized vacuum-tube rectifiers for radar while the United States turned to high-purity crystalline semiconductors — a new technology that later became the foundation for dramatic solar cell progress. In 1954 came Bell Laboratories' major breakthrough of a 6-per-cent efficient solar cell.

Three years later the see-saw changed again as the Soviet space program brought a revival of interest in photovoltaics. "Solar cells were immediately seen as the ideal power source for space vehicles," Mr. Scher notes, and Soviet solar cell research started anew. While the U.S. was ready to use solar cells on its first satellite, *Vanguard I,* the technology first appeared on *Sputnik III.* Thereafter, Soviet research prospered, and solar cells beyond those needed for the space program were used for some rather exotic solar-powered machines, and for small scale terrestrial generators.

Meanwhile, disillusionment with solar cell potential spread in the U.S. in the 1960s with the gradual realization that the economic barriers would not be overcome as earlier anticipated. The Soviets came to that realization later, and it coincided with their new optimism about nuclear power, which then claimed their major attention.

Today, while the U.S. pursues broad scientific and engineering programs in photovoltaics, as well as planning, economic, and even legal analyses of terrestrial solar energy, the U.S.S.R. assigns its photovoltaic studies to academic and basic research institutes rather than industrial enterprises. Solar generation there is treated only "as a quite long-term reality," says Mr. Scher. "The nuclear century will be followed by the century of solar energy utilization," according to one leading Soviet solar engineer. — *J.M.* □



Jon McIntosh

Enter Buck Rogers with an Oil Shale Extractor

Though would-be developers complain about the legal and environmental roadblocks to exploitation of the immense U.S. oil shale resource (some 600 billion barrels), economic constraints are the real issue: even as world oil prices advance, the cost of oil from shale — though apparently less than the cost of oil from coal — stubbornly remains too high.

Can the cost be reduced in the future? The M.I.T. Energy Laboratory convened a panel of 20 experts last summer to study the problem with support from the Edna McConnell Clark, Ford, and Alfred P. Sloan Foundations. After a good deal of speculative engineering, the panel turned in an optimistic report. Large-scale production of shale oil (at least 2 million barrels a day) would make possible some significant economies in the process, and the United States ought to look seriously at this possibility.

Here are two of the experts' suggestions:

□ *Mining.* Conventional underground mining of the 3 to 8 million tons per day of oil shale required to produce enough oil for these economies is almost unthinkable. So the conferees suggested surface mining and "underground surface mining," an apparent contradiction in terms that refers to underground operations so large that the machines and methods of surface mining can be used. German success with mining lignite under 900 to 1,600 feet of overburden was noted.

□ *Retorting.* Oil is removed from shale with heat, and no one suggested any other way of doing it. But new technology might shave costs. For example, retort systems could be made more flexible so they could accept different grades of shale and produce different products, depending on demand (oil, gas, or steam). Retorts could be larger (using fluidized-bed systems, which have not been considered recently), and operated under higher pressures for greater efficiency. An all-out program to produce 2 million barrels of shale oil per day would mean that retorts could be mass produced, resulting in more savings.

But these suggestions did not instill unrestrained confidence in the economic feasibility of shale oil production. So the conferees made a far bolder "systems" proposal: "Imagine a 1,000-ton extraction device," they wrote, "which travels through the shale — a frontal area of 10 square meters advancing 60 centimeters a minute — breaking rock, heating the rubble, separating the oil and gas, cooling the solid residue, and replacing the rock in the mined-out volume." The whole process would be remote-controlled, with products pumped to the surface through pipes at the rate of 5 million barrels of oil per day.

Two questions arise. The cost of such a device might be as high as $30 million. However, with only 50 per cent utilization, it would yield much more than that sum's worth of oil every year.

The great volume of wastes produced by such production could pose a serious problem: in conventional retorting the

volume of tailings is larger than the volume of the original shale. But retorting could be done at high temperature and the tailings promptly compacted.

"No such device is under development, or has even been thought about seriously to our knowledge," the conferees wrote, admitting that their suggestion may not be practical. They offered it, though, only as an example: "There are other ways of thinking about shale oil recovery that should be studied, at least," they wrote, and they propose creation of a publicly held firm similar to Comsat (the satellite communications organization) to get on with the job. — *J.M.* □

Last Line

The Writing on the Wall

Before they started saying "Drink Coca Cola," the wall posters of Peking reflected the thinking of China's leaders — a simple and direct way to communicate with the people. But now, alas, this practice seems to have been abandoned, and more modern methods prevail.

Such tradition lives on, sort of, at M.I.T. Every week or so, large sheets of paper, blank save for a "come-on" statement at the top, are affixed by students to the pillars of "Lobby 7" — the Grand Central Station of the Institute.

Often the initiating statement and its responses are of interest only to the M.I.T. community. But at other times, the whole world should be watching. Thus, when the graffiti-beckoning declaration — posted shortly before the Kemeny Commission issued its report on Three Mile Island and nuclear power plant safety — was "More people died at Chappaquidick than at Harrisburg," this reader of wall posters was motivated to share some of the results with *Technology Review* readers. — *S.J.M.*

Who Is (Are) the Victim(s)?

"I was the only victim of Three Mile Island" — Dr. Edward Teller [in a newspaper ad].
Father of the A-Bomb.
H-Bomb, twit!

You'd absorb more radiation living in Colorado for a year than you would have received standing naked (i.e., unprotected) outside Three Mile Island for the entire length of the accident.

In New Jersey, where I live, cancer comes from the air, water, and food thanks to our wonderful chemical companies. At least if I got nuked, I'd know it.
Serves you right for living in Jersey.

Anyone who has ever smoked a cigarette or sat in the same room as someone with a cigar has no right to complain about miniscule increases in cancer risk from incidents like the one at Harrisburg.
Big difference. Sitting/smoking is voluntary.
Oh, really? Do (choke) tell.

How many coal miners die every year?
About as many as uranium miners.
Bull—. There aren't as many uranium miners.
However, three people did *die at the explosion of a very small SL-1 reactor back in the early 1960s someplace in Idaho or Washington (I forget exact details).* And, *it is now coming to light that in 1958 an "explosion" due to poor nuclear waste storage occurred in Siberia – the same situation that currently exists in Hanford, Washington and West Valley, New York.*
My father worked for C.E. [Combustion Engineering] when this happened at the Idaho test plant. Yes, three people died. They did a very stupid thing and got what they asked for.

Nuclear power racks up probabilistic deaths. Coal mining racks up real deaths. I'll go with the better statistics.
You deserve to be a statistic.
You deserve to be an incorrect statistic.
Better alive and a statistic than really dead.

Threats to Beat the Ban

If you want to stop cancer, stop the government from subsidizing tobacco.

Let's protect against the cancerous growth of excessive bureaucratic regulation of American business.

Cosmic rays cause cancer and mutagenic effects. Let's ban all sources of this deadly radiation.
Megadoses of distilled water (H_2O) cause cancer when injected into laboratory animals. Let's ban this killer, too.
Have you ever noticed how much granite was used in the construction of M.I.T.? Especially with high-potassium feldspar content? I think it's a plot to nuke us all with K^{40} radiation.

Grow up before it's too late. You M.I.T. students are still in the 50s when nukes were fun things to play with.
Obviously someone from Hahvahd.

Why don't we ban *everything* new? What happened to faith in technology?

Point of Information

Q: What's a nuke?

A: Not much. What's a-nuke with you?

In Search of a Cause

The only "nukes" which are about to kill a large number of people are the ones designed for the Pentagon. What the hell are the activists doing about these?
Right on!

They just need something to protest about. Something "anti-establishment." Why not complain about something that actually affects people, like CRIME. Doing just a little to decrease crime and violence will save a lot more lives and injuries than closing all nuclear power plants.
Crime does not play.
In Peoria, that is.

Clamshell is nothing more than a front for the Communists. Do you want to help "liberate" America?
Comments like this illustrate the mentality of anti-anti-nuclear people.
How about anti-anti-anti-nuclear people?
Let's generalize. How about (anti-)^n nuclear people?

Those of us who favor nuclear power development do not claim it to be the final answer. However, it is *right now* the safest available technology for producing electrical power on a large scale. If you "anti-nukes" want to go back to a society where people lived off the land, burned wood, and died at the average age of 45, go right ahead — I'm sure you can find a remote spot in Maine or Vermont or Idaho on which to build your log cabin. I'll take the present-day society, with its inherent risks, and its average lifespan of 70-75 years.
Pro-nukers are fighting change by sticking to the status quo, while no-nukers

realize that life can be changed for the better. Nukes are but a symptom of centralization and decreased self-reliance, which cause alienation, apathy, cults, me-generation attitudes, loss of personal integrity, etc.

Slogans for the New Age

More nukes, fewer kooks.

Melt down discos.

Nuke the whales.

Nuke baby seals.

Mutations are America's hope for the future.

Every day, thousands of tons of innocent rocks are brutally mined, burned, crushed, and in general die horrible deaths. *You* can help put a stop to this senseless slaughter. Or one of these days there may not *be* any more rocks. Get to work *now*. Don't treat them like dirt. Save the rocks!

Such Waste

Decrease population: build a power plant; store waste.

Nuclear wastes are containerized. Better than burning oil.
And they leak.

After less than about 500 years, this stuff is no more dangerous than the ore it was mined from.
I feel a lot more secure knowing the stuff is dangerous for "only" 500 years and not half a million.

The Big Picture

What about the social and political aspects of nuclear power?
☐ *In the Western world, nuclear installations and radioactive material are attractive targets for terrorists and have to be protected. And stringent security measures must be enforced.*
☐ *In the Third World, more and more countries with unstable governments or aggressive expansionist policies are acquiring nuclear weapons. If you're not a total moron, that should make you worry.*
☐ *It's true that nobody died at Harrisburg (yet) as a result of Three Mile Island. But were the people of Harrisburg asked if they wanted a nuke next door in the first place? Nuclear power is all about faceless men making decisions which affect our lives but which we can't control.*

There are sane, practical alternatives to nuclear power — it is not a choice between freezing and glowing. ☐

Carey/Continued from page 12

very big effort. This means a majority coalition that won't split — one which includes industry, labor, economists, professional groups, media, and elected representatives that is well-grounded with information and can sustain itself over the five to ten years necessary to reverse the current situation.

These are some of the dimensions of the outlook, as I see them. My own guess is that it is not in the cards for government to come forward and wage a crusade for heroic policy changes in the interests of technological innovation. But I also think we can expect something positive in the way of gradual, step-by-step reform and reorientation in public policies which affect risk-taking and large new ventures. Incrementalism is built into our political system; and, given the tilt of public opinion towards conservatism in government, I think that the incremental path is the only one with a chance. What this says then is that the outlook may be for an orderly, multi-year effort starting with administrative measures and leading to selected legislative changes. Even these will require commitment and steady policy management in government, and especially a consensus in the senior policy councils of successive administrations.

Meanwhile, a tremendous amount of education needs to be done to prepare the ground for sequential actions on behalf of innovation. Little has been done to focus the problem of innovation and its constraints in the print media outside of the *Wall Street Journal* and *Business Week*. If we face a policy hiatus until the 1980 elections are over, that time can be best used by business and labor working together to inform and convince the public and the Congress that our economy, nationally and internationally, is going downhill in technological innovation, and that government and the market economy must work together while there is still time.

It can be argued, of course, that even if government is not ready to work for high-leverage policy changes of a direct sort, there may be some indirect impetus to innovation in the 1980s from the buildup of defense spending, military research and development, and investment in new energy technologies. This is possible and even likely. But it is not a basic answer, and it contributes little to correcting the chronic economic mess of continued inflation, pressures on capital and savings, and other disincentives to new company formations. At best, these developments might put a floor under falling innovation and productivity without actually turning the syndrome around.

As I said, my friend at Ohio State spoke well and truly. Even on a clear day you can't see very much. □

Books/Continued from page 18

Seveso River and on to other communities, including Milan. Visiting the town one year later, Whiteside wrote that "it has become apparent that dioxin contamination exists well beyond the borders of the area designated as polluted."

As part of the clean-up effort, all tree limbs, leaves and vegetation, and 300,000 tons of topsoil were removed. The dioxin release and the clean-up effort was enough to cause an economic depression in the entire region. Real estate became worthless, making residents who wished to leave unable to do so. Carpenters, masons, and contractors were put out of business as construction halted. Farms, bakeries, and thriving orchards were destroyed or left with no markets. Seveso's furniture industry, which once supplied a major share of Italy's households, was nearly destroyed by fears that the wood itself was contaminated. Adding insult to injury, Switzerland, whose nationals were owners of the exploding factory, was among countries placing an import ban on furniture from Seveso.

Residents of the town found themselves viewed in the same light as their furniture. To Italian society at large, the disaster victims were pariahs, as if contact with them were enough to spread the deadly contamination.

Whiteside's history of industrial accidents involving dioxin shows that handling the chemical precursors of 2,4,5-T and silvex is a dangerous business. Meanwhile, further accidents and disasters like Seveso are a frightening possibility. Last July, a plant in Arkansas leaked dioxin-contaminated waste. More than a dozen workers contracted chloracne, and dioxin was found in a stream and in vegetable gardens near the plant. Through spraying alone, up to four million people would have remained at risk of exposure if the present suspension had been delayed another year.

The Need for a Larger View

The most disturbing aspect of the current dioxin controversy, and particularly the arguments presented in recent hearings, is the complete exclusion of the larger issue of environmental contamination by chemicals, such as dioxin, that even at very low levels are extraordinarily toxic and persistent. Even if the Environmental Protection Agency permanently removes 2,4,5-T and silvex from the market, a wide array of products would remain as potential sources of dioxin contamination, according to Whiteside. For example, dioxins are found in a large group of fungicides and preservatives that have seen wide commercial use in such products as adhesives, paint, paper, shampoos, and laundry starch. In addition, halogenated aromatic compounds, the larger class of chemicals that includes 2,4,5-T and its precursors, have been indicted because of health effects disconcertingly similar to dioxin's. But the difficulty of determining health effects of products containing these chemicals, despite their known toxicity, may yield evidence insufficient to enact a permanent ban.

Regulators need to be aware of the total health burden represented by this wider variety of materials. "Surely," Whiteside wrote, "what proper regulation should protect the public from is not only the effects of particular product brand formulations but the collective and cumulative effects over the long term of whole classes of chemical compounds."

William M. Hastie is a graduate student in science communications at Boston University and the Biology Department librarian. □

Solution to November Crostic

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N. Equivocated
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You're looking at a new electronic switching system. And the beginning of an exciting future.

This system, based on advanced microelectronics, is helping us handle more calls faster than ever before.

It can store information and instructions about millions of calls. Then process them in a fraction of a second.

This capability can tell you a call is waiting. Or, in the near future, will allow you to screen out communications except those you pre-select.

There will be many more services in the years ahead. Right now, the task at hand is to install electronic switching across the country. So it can do more for your communications now. And in the future, carry most any kind of communication you can think of: voice, data, printed words, even pictures.

Bell System people are meeting the challenge of the 21st century, installing entire electronic switching systems at the rate of one per business day.

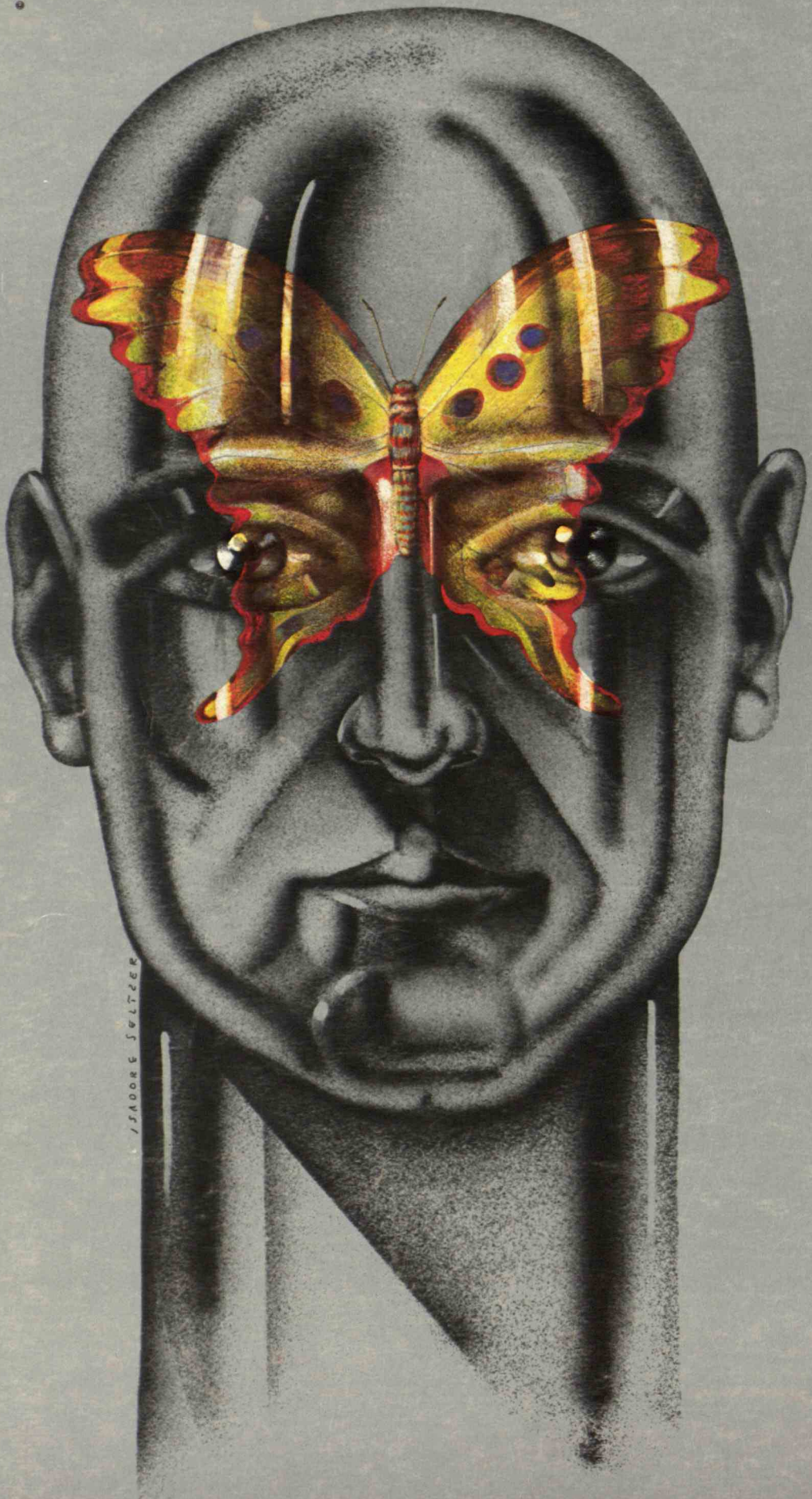
Every working day they're bringing the future closer to home.

A new electronic switching system under construction.

Electronic switching will make your phone more versatile.

Bell System

Keeping your communications system the best in the world.



Imagine tomorrow as beautifully complex.

Not fearfully so.

The pace of change is becoming even faster, now that the era of cheap and plentiful energy has ended. But that doesn't mean the future has to be a shock.

Most Americans have never feared the future. Because we've discovered that challenge stimulates invention and imagination, and incubates a thousand bright and complex new ideas. Ideas to transform America into the balanced society of the future—where growth and the environment are seen not as enemies but as the dual face of one national purpose.

Finding that balance will be the most arduous stage of the transformation.

That's why we've stressed the need for debate and compromise as America weighs its environmental and energy needs. And why we joined vigorously in the debate ourselves.

We've called for reasonable balance between clean air and decent jobs, between wilderness and resource development, between energy sources for now and alternative sources for the future.

America will need every one of its abundant forms of energy to keep tomorrow bright. Whatever the complexities it may bring.

Mobil

Speaking out for tomorrow...today